Hagenson, I. 1984

A Fisheries Inventory of Sasaginnigak and Charron lakes, 1979

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ABSTRACT

These inventories were conducted between June 23 and July 25, 1979 to determine the sport fish potential of the lakes, assess the impact of commercial development on the sport fish populations and to provide baseline data to permit development of an allocation and use strategy for the fisheries resource. Sasaginnigak and Charron lakes are mesotrophic, Precambrian Shield, headwater lakes and, as such, are fairly low in productive capacity. Both lakes appear to be supporting the climax biomass of fish of which they are capable.

Lodge users have cropped most of the larger, older trophy northern pike from both Charron and Sasaginnigak lakes. However, the lake trout and walleye populations of these lakes have not been adversely affected. The number of outcamp beds on Charron Lake should not be increased as such a move may have a detrimental affect on the lake trout stocks of the lake. Sasaginnigak Lake is overbedded and no further expansion should be considered for this lake. In fact if it was economically viable, the lodge should consider reducing the number of beds toward the estimated capacity of 35. This may improve

the trophy potential of the walleye and northern pike populations of Sasaginnigak.

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INTRODUCTION

This inventory of Sasaginnigak and Charron lakes was conducted between June 23 and July 25, 1979. The objectives of the inventory were to determine the sport fish potential of the lakes, assess the impact of commercial development on the sport fish populations and to provide baseline data to permit development of an allocation and use strategy for the fisheries resource.

Sasaginnigak and Charron lakes are remote fly in lakes which have been commercially developed. Sasaginnigak Lake has one lodge with a capacity of 54 beds and Charron Lake has two outcamps with a capacity of 14 beds. The results of two angler surveys, 1972 and 1981, showed an increase of 48,625 angler days were spent in the East Central portion of Manitoba. Most of the angler days were exerted by guests of lodges in the East Central area.

Both lakes also have had a winter commercial fishery. The winter fishery on Sasaginnigak was quite limited. It was only fished 7 years from 1951 to 1963 and the 11,364 kg quota was never attained. Charron Lake had a more extensive commercial fishery. The winter operation ran from 1948 to 1978 and the 11,364 kg quota was exceeded four times.

The Study Area

Sasaginnigak Lake is located approximately 209 km north-east of Winnipeg at 51°36' latitude (N) and 95°39' longitude (W).

It is a headwater lake of the Bloodvein-Gammon River system and has a drainage basin of 461 square kilometers (Table 1). The principal inflow and outflow is the Sasaginnigak River (Fig. 1).

Charron Lake is located approximately 338 km northeast of Winnipeg at 52°44' latitude (N) and 95°15' longitude (W). It is a headwater lake of the Hayes-Severn River system and has a drainage basin of 451 square kilometers (Table 1). The main inflow and outflow is the Palsen River (Fig. 1).

The geology of the area is Precambrian Paleozoic and Mesozoic bedrock of various lithologies and the topography is rolling to hilly in nature (Weir 1983). A more detailed description of the geology and soil composition of the area may be obtained from Dutchak et al. (1978).

The natural vegetation of the area is northern coniferous forest consisting mainly of black spruce (Picea mariana), white spruce (Picea glauca) and balsam fir (Abies balsamea). There is jackpine (Pinus banksiana) in recent burns with white birch (Betula papyrifera) and balsam poplar (Populus balsamifera) (Weir 1983). A detailed mapping of the vegetation surrounding each lake may be obtained from the Forest Inventory section of the Department of Natural Resources.

Table 1. Drainage divisions and watershed units of Manitoba that contain the inventoried lakes.

Principal Drainage Division			Major Drainage Division			Watershed Division			Lake
No.	Name	Approx. area in Manitoba in Km^2	No.	Name	Approx. area in Manitoba in Km^2	No.	Name	Approx. area in Manitoba in Km^2	
5	Nelson River	313,131	5RB	Bloodvein River division	5861	5RB-F	Sasaginnigak River	461	Sasaginnigak
4	Hayes and Severn Rivers	91,298	4CA	Severn River upper division	3015	4CA-M	Palsen River	451	Charron

from Fedoruk (1970)

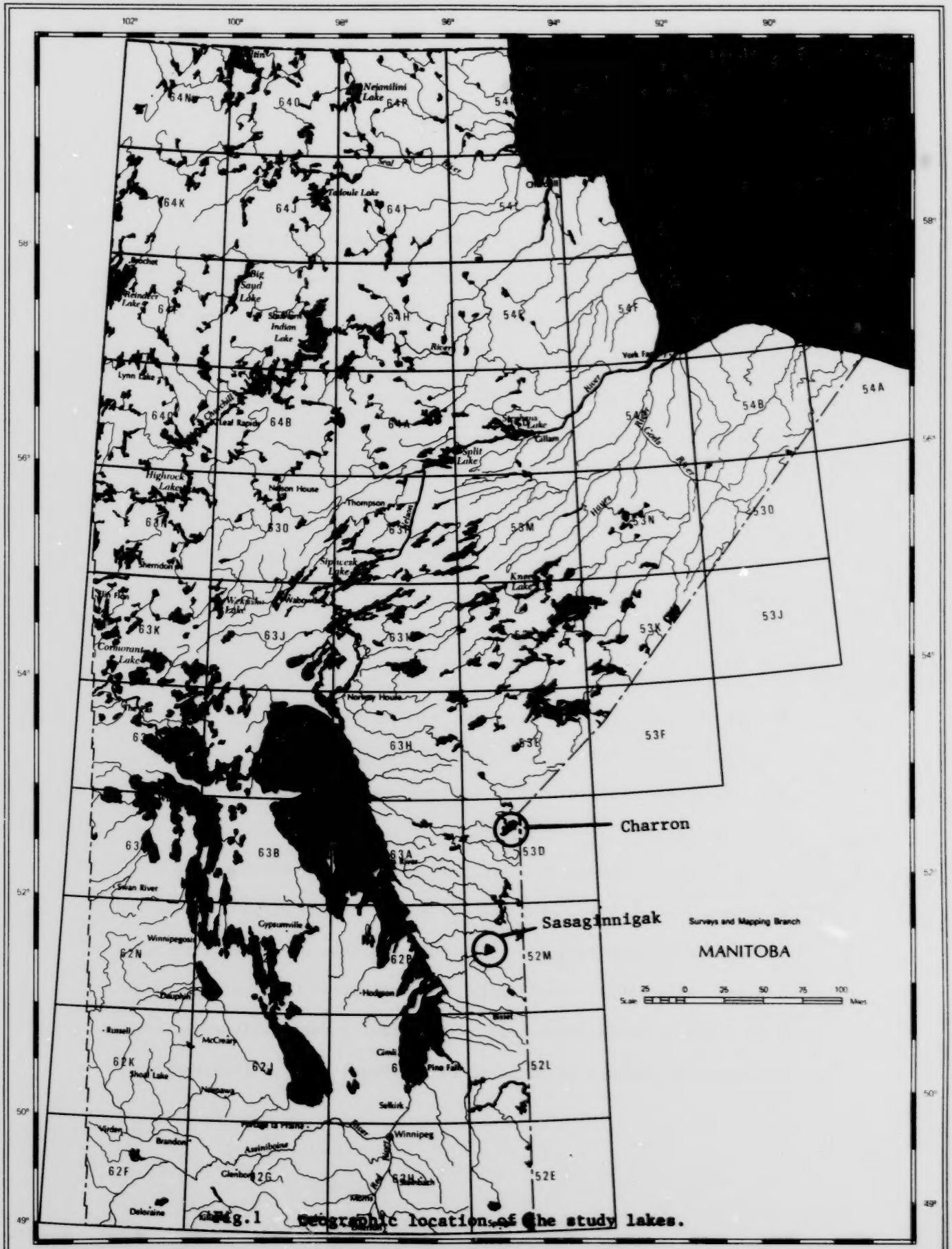


Fig.1 Geographic location of the study lakes.

METHODS

Morphometry

The depth sounding in this survey was done with a Furuno FG200 MK3 unit with a range of 0 to 87 meters. Sounding transects were drawn in the field on photobase mosaics of the inventory lakes. The completed bathymetric maps were used to determine lake area, volume, mean depth and shoreline development according to procedures described by Hutchinson (1957).

Physical and Chemical Parameters

Field measurements of water temperature, dissolved oxygen, conductivity, pH and transparency were taken. The water temperature and dissolved oxygen profiles were recorded at one meter intervals from the surface to the bottom with a YSI electronic instrument. The specific conductivity was measured at the surface with a YSI electronic instrument. The pH was measured with a Hach wide range colour comparator field kit. The transparency was measured with a standard limnological Secchi disc according to Welch (1948).

Water samples for chemical analysis were taken from two locations at each lake. Two one litre and one 500 ml samples were collected from each location. The 500 ml sample was fixed with 2.5 ml nitric acid (50%). The samples were submitted for analysis within 24 hours of being collected. Water samples were analysed by the Environmental Management Division of the Department of Environment

and Workplace Safety and Health.

Plankton

Plankton samples were collected at the water chemistry locations with a Wisconsin plankton net with an opening diameter of 24 cm and a mesh size of 73 µm. The samples were preserved in the field in 10% formalin. Plankton was identified in the laboratory.

Benthos

Benthos samples were also collected from the water chemistry locations with a 15 cm by 15 cm Ekman dredge. The samples were immediately washed using a bag of 400 µm Nitex and preserved in 10% formalin for later identification in the laboratory.

Fish

Small fish specimens (forage fish) were collected by seining a suitable area with a 1.2m by 7.4m seine of 6mm oval mesh. These were supplemented with samples taken with the fish toxicant, rotenone.

The sport species, i.e. walleye (*Stizostedion vitreum*), northern pike (*Esox lucius*) and lake trout (*Salvelinus namaycush*) were captured with standard gang gill nets. Each standard gang consisted of six gill nets with the mesh sizes in the following order: 3.8cm, 9.5cm, 5.1cm, 10.8cm, 7.6cm and 12.7cm. Each gill

net was 22.9m long and 1.8m deep. Gangs were set overnight for approximately 16 hours. The standard gang net sets were rotated around the lake to sample as many different habitat types as possible.

Walleye, northern pike and lake trout were sampled for fork length, weight, sex, maturity and stomach contents. All other species were sampled for fork length and weight only. For age determination, otoliths and the first two dorsal spines were taken from walleye and otoliths and the first two pelvic rays were taken from lake trout. From pike, cleithra and the first two pelvic rays were taken for ageing. Otoliths were prepared and aged according to the procedures described by Erickson (1979). Cleithra were cleaned of skin and aged using an illuminated magnifying glass. The other structures were not aged at this time.

Calculations

Procedures described by Snedecor and Cochran (1967) were followed for statistical analyses. The morphoedaphic index (MEI) was calculated according to Ryder's (1965) formula for moderately to intensively fished lakes. The trophic state of the lake was determined using the trophic state indices (TSI) described by Carlson (1977).

The mean weighted age at onset of sexual maturity (Z) was calculated by the equation:

$$Z = \frac{A_1K_1 + A_2(K_2 - K_1) + A_3(K_3 - K_2) + \ldots A_n\ (K_n - K_{n-1})}{K_1 + (K_2 - K_1) + (K_3 - K_2) + \ldots (K_n - K_{n-1})}$$

where A = age (years)

K = % of mature fish in the n^{th} age class.

This is a corrected form of Abrasov's (1967) original formula.

Asymptotic length (L_∞) was determined from the plot of $\ell_t + 1$ vs ℓ_t, as described by Walford (1946). The growth coefficient (k) was described by Brody (1927) as the slope of the plot of log $(L_\infty - \ell_t)$ vs t. The parameter t_o equals the natural log intercept of $\log_e (L_\infty - \ell_t)$ divided by k. Fish growth was described by Von Bertalanffy's (1938) equation:

$$\ell_t = L_\infty (1 - e^{-k(t-t_o)})$$

RESULTS

Morphometry

The shorelines of Sasaginnigak and Charron lakes are fairly diverse with shoreline development indicies of 6.37 and 9.65 respectively (Table 2). Bathymetric maps of the lakes are presented in Figs. 2 and 3. All depth contours are in meters.

Table 2. Morphometric data for Sasaginnigak and Charron lakes.

Parameter	Value	
	Sasaginnigak	Charron
Net water area (ha)	4853	5314
Maximum depth (m)	18.0	70.0
Mean depth (m)	5.5	17.8
Volume ($m^3 \times 10^6$)	267.011	947.847
Length of mainland shoreline (Km)	157.30	249.36
Length of island shoreline (Km)	125.93	104.46
Total length of shoreline (Km)	283.23	353.82
Shoreline development index	6.37	9.65

SASAGINNIGAK LAKE
1:20 000
SCALE 0 500 1000 METRES
CONTOURS IN METRES
N

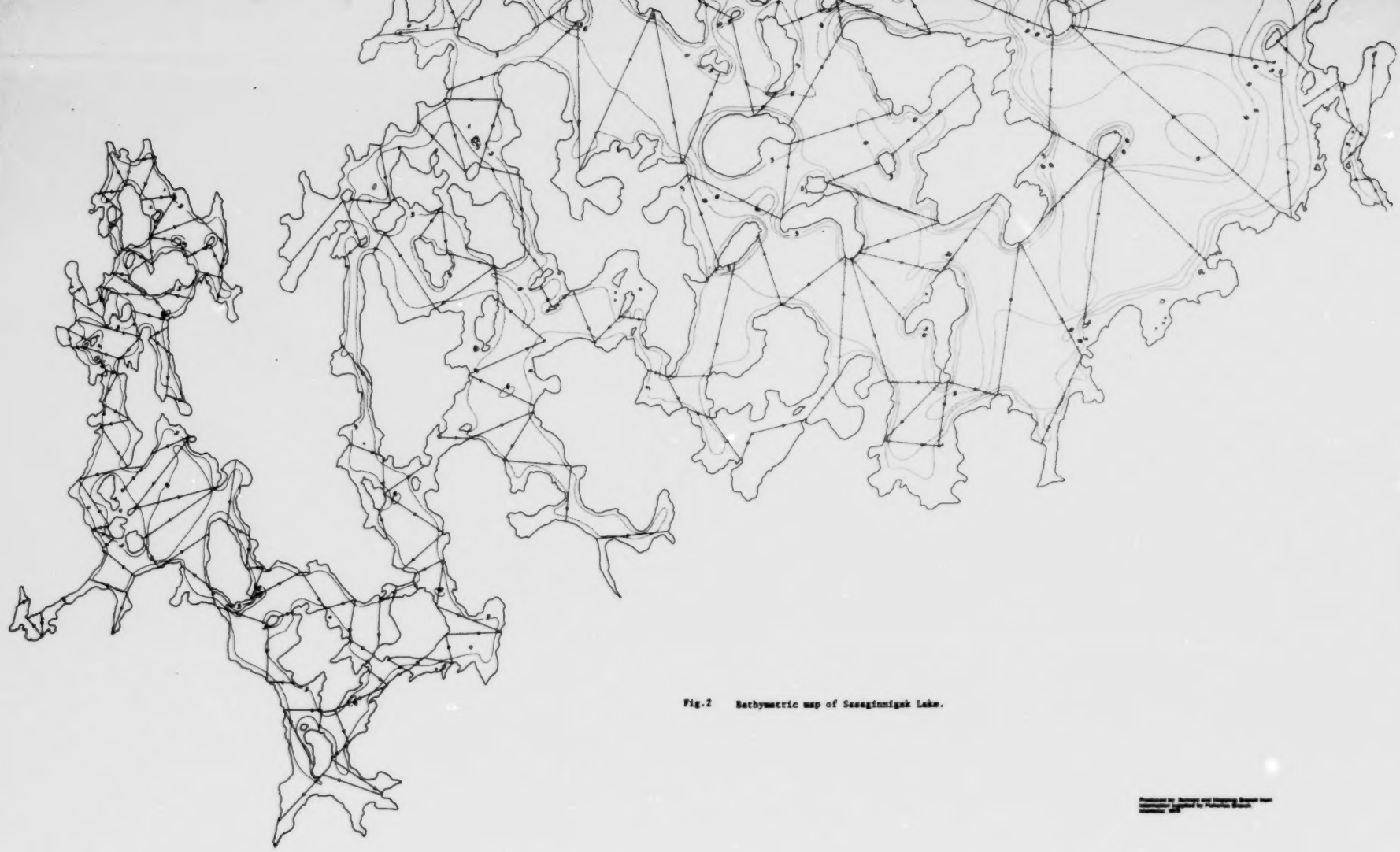


Fig.2 Bathymetric map of Saseginnigak Lake.

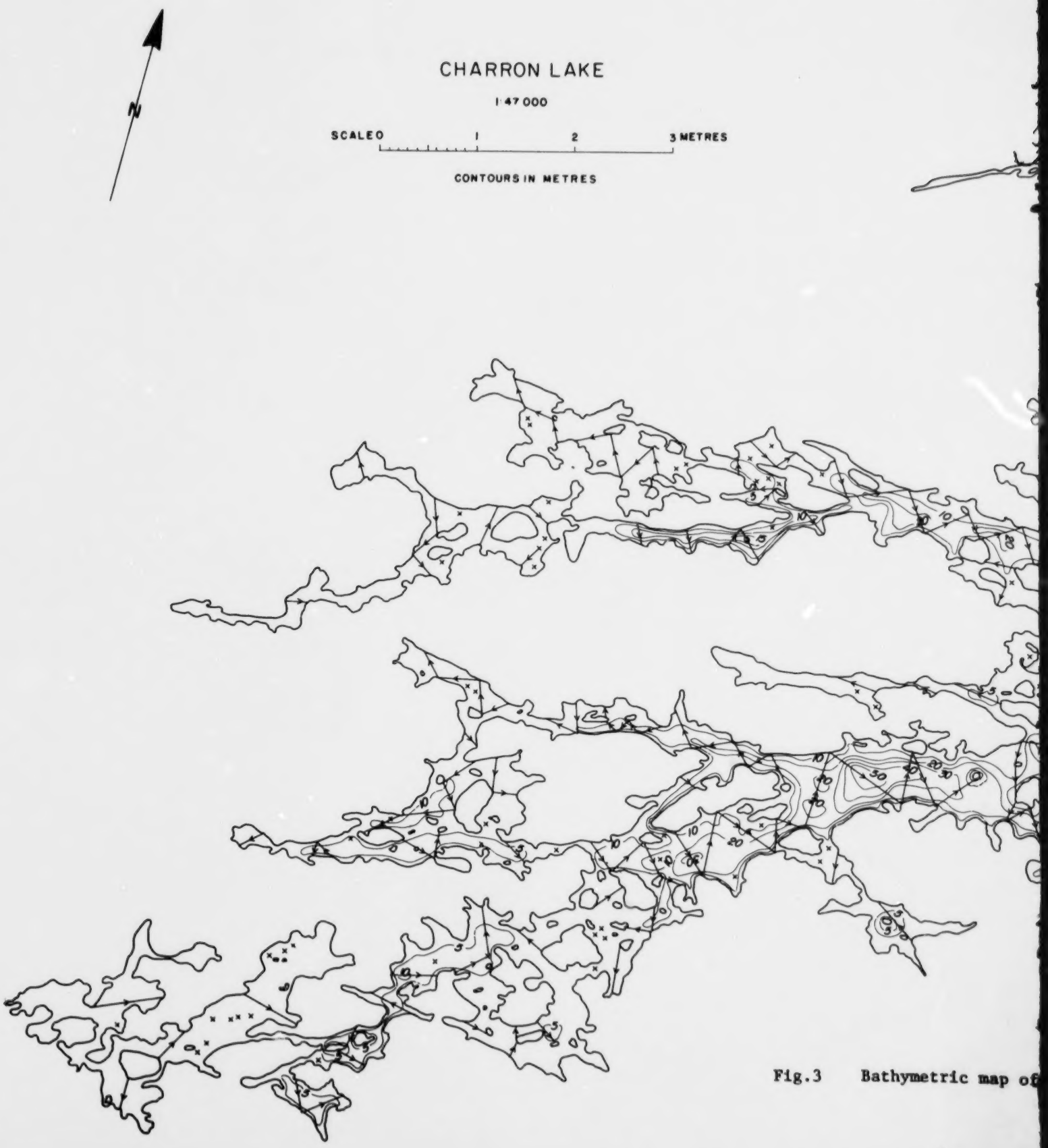
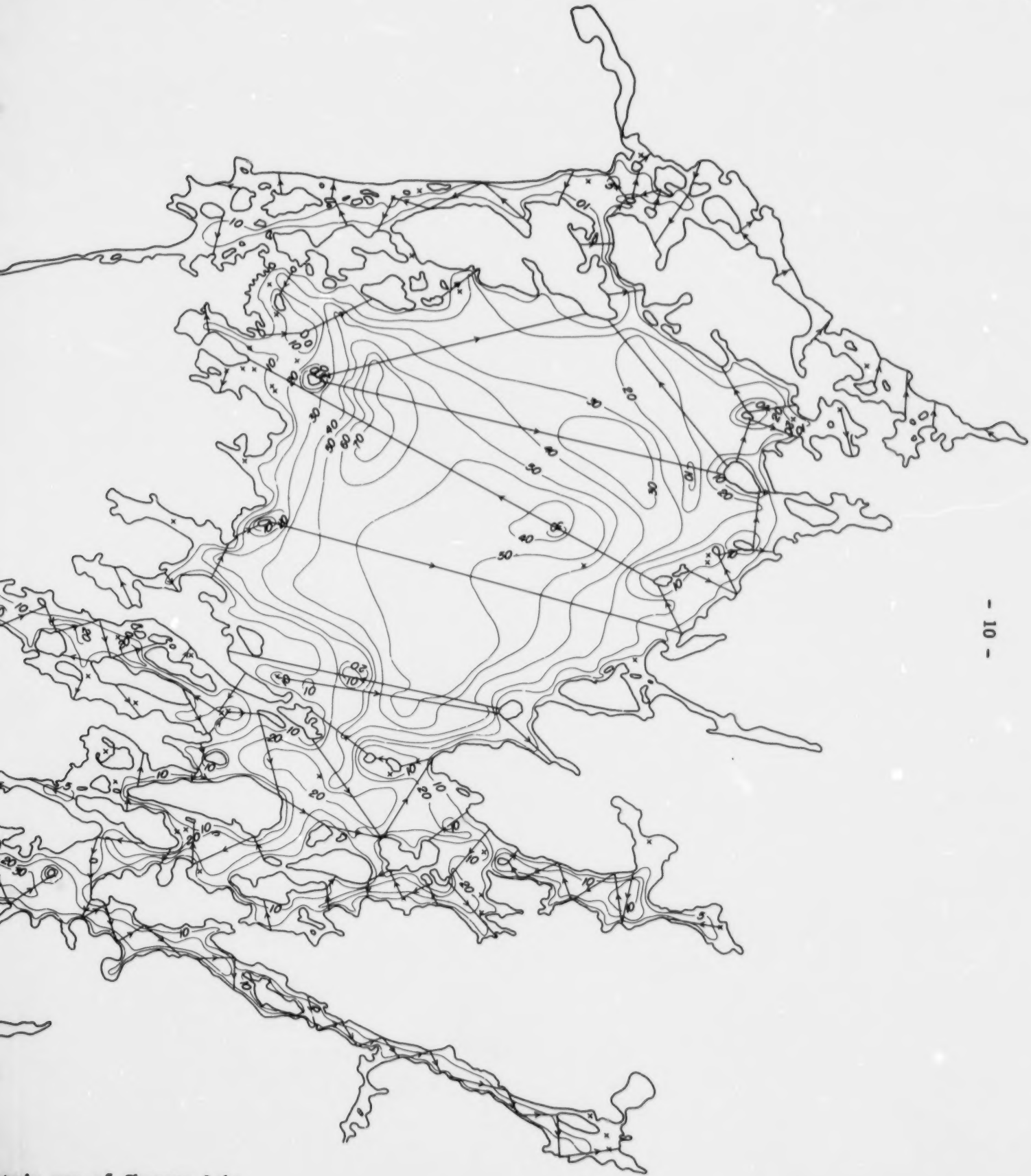


Fig.3 Bathymetric map of



tric map of Charron Lake.

Produced by : Surveys and Mapping Branch from information supplied by Fisheries Branch, Manitoba, 1979.

Physical and Chemical Parameters

The Secchi disc transparencies (m) for each lake were as follows:

Sasaginnigak	1.7	June 27, 1979
Charron	3.2	July 25, 1979

Temperature and dissolved oxygen profiles of the lakes (Fig. 4) showed Sasaginnigak to be isothermal with near saturated levels of dissolved oxygen. Charron exhibited thermal stratification at the 9m level, however, dissolved oxygen concentrations were near saturation above and below the thermocline. The locations of the sampling stations are illustrated in Figs 5 and 6.

Analysis of the water samples collected July 25, 1979 from Sasaginnigak and Charron lakes, indicated mean conductivities of 28.0 µmho cm^{-1} and 30.3 µmho cm^{-1} respectively (Table 3). Dissolved nitrogen (NO_3 - NO_2 - N) concentrations were low at <0.01 mg ℓ^{-1} and total phosphorus levels were <0.02 mg ℓ^{-1} in each lake.

Fish

Sixteen species of forage fish were collected from Sasaginnigak and Charron lakes. There were fifteen species collected from Sasaginnigak with the most numerous being Spottail shiners (*Notropis hudsonius*) and Johnny darters (*Etheostoma nigrum*). There were only seven species of forage fish captured in Charron Lake. Brook sticklebacks (*Culaea inconstans*) were the most numerous (Table 4). The locations of the collection sites are illustrated in Figs. 5 and 6.

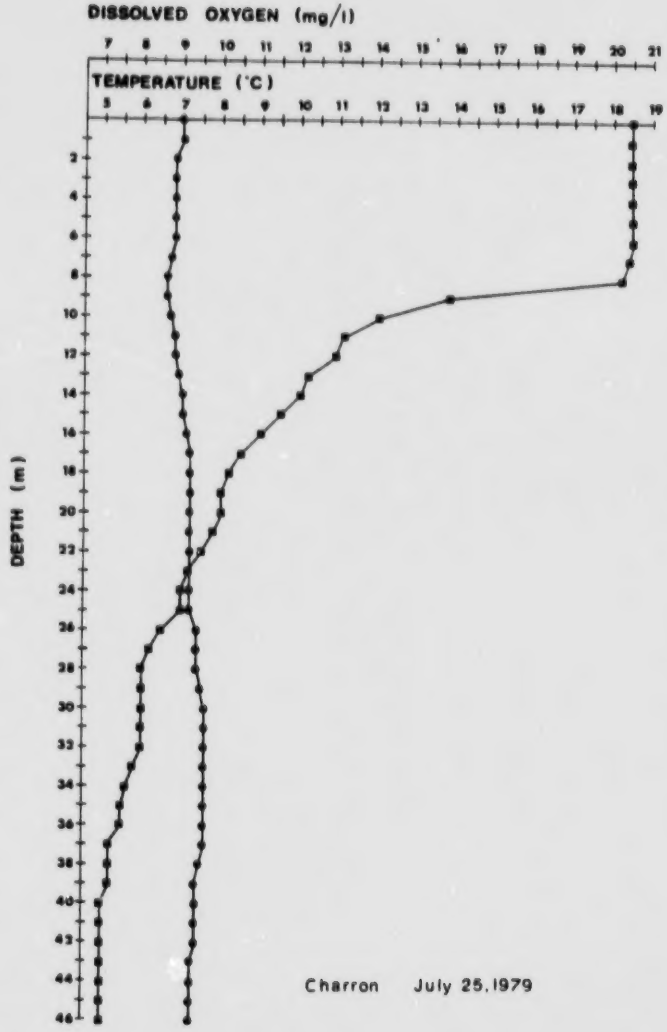


Fig.4 Temperature ■ dissolved oxygen ● profiles of Sasaginnigak and Charron lakes.

SASAGINNIGAK LAKE
1:20 000
SCALE 0 500 1000 METRES
CONTOURS IN METRES
LEGEND
Water Sample Stations
Chemical Stations
Gill Net Sets
Small Fish Collection Sites
N
WW 1
WW 2
WW 3
WW 4
WW 5
WW 6
WW 7
WW 8
WW 9
WW 10

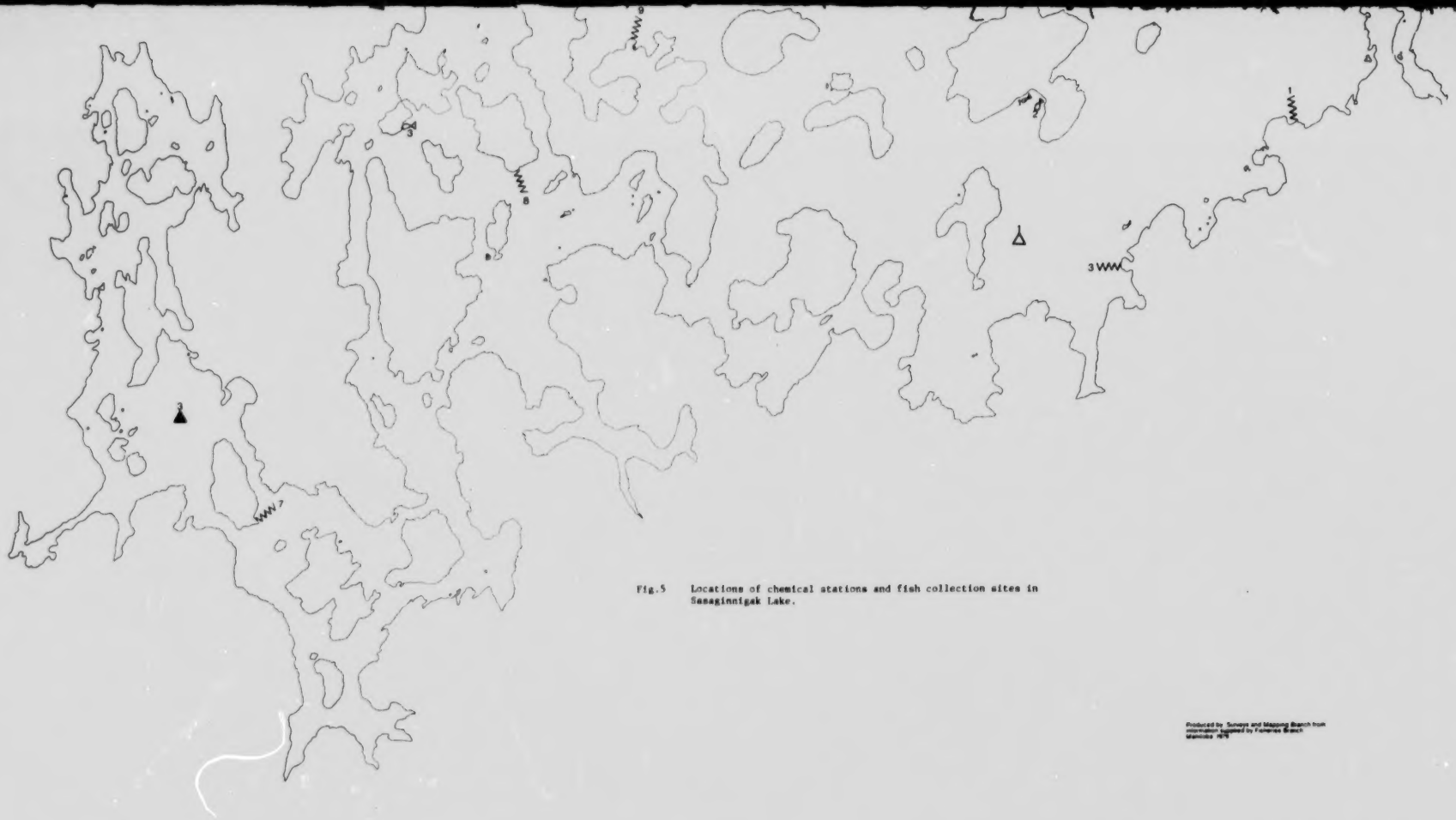


Fig.5 Locations of chemical stations and fish collection sites in Sasaginnigak Lake.

Produced by Surveys and Mapping Branch from information supplied by Fisheries Branch
Manitoba 1979

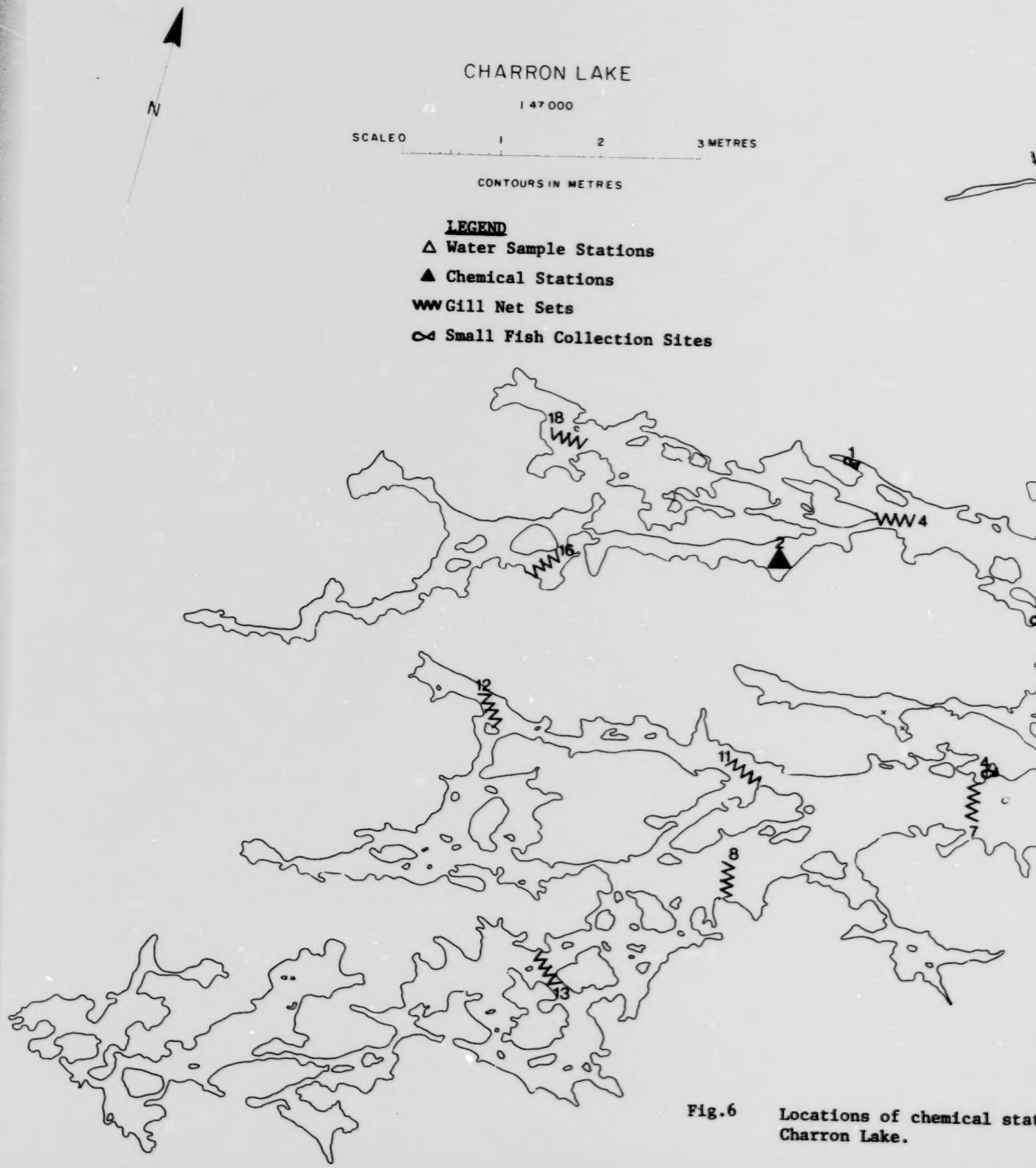


Fig.6 Locations of chemical stat
Charron Lake.

s of chemical stations and fish collection sites in
Lake.

Produced by : Surveys and Mapping Branch from information supplied by Fisheries Branch, Manitoba ,1979.

Table 3. Water chemistry analyses of Sasaginnigak and Charron lakes, July 25, 1979.

Parameter	Sasaginnigak			Charron		
	Δ1	Δ2	Mean	Δ1	Δ2	Mean
Conductivity (Field) (μmho cm^{-1})	25.0	24.0	24.5	25.0	26.0	25.5
Conductivity (Lab) (μmho cm^{-1})	27.7	28.3	28.0	29.0	31.7	30.3
Total dissolved solids (mg ℓ^{-1})	42.0	48.0	45.0	28.0	34.0	31.0
Total suspended solids (mg ℓ^{-1})	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
pH (Field)	6.8	6.9	6.85	7.1	6.95	7.0
pH (Lab)	7.0	7.0	7.0	6.95	7.1	7.0
Alkalinity Total ($CaCO_3$) (mg ℓ^{-1})	10.0	10.0	10.0	10.0	14.0	12.0
Hardness ($CaCO_3$) (mg ℓ^{-1})	34.0	34.0	34.0	33.0	33.0	33.0
Calcium - extractable (mg ℓ^{-1})	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Magnesium - extractable (mg ℓ^{-1})	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Potassium - extractable (mg ℓ^{-1})	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Sodium - extractable (mg ℓ^{-1})	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Total organic carbon (mg ℓ^{-1})	15.5	16.5	16.0	30.5	13.0	21.7
Total inorganic carbon (mg ℓ^{-1})	<1.5	<1.5	<1.5	6.5	4.0	5.2
Colour	50.0	50.0	50.0	10.0	10.0	10.0
Turbidity (NTU)	1.0	1.0	1.0	1.5	1.0	1.0
NO_3 - NO_2 - N dissolved (mg ℓ^{-1})	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phosphorus total (mg ℓ^{-1})	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chlorine soluble (mg ℓ^{-1})	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Sulfate soluble (mg ℓ^{-1})	5.0	5.0	5.0	8.0	8.0	8.0

A total of thirty standard gangs were set in Sasaginnigak (10) and Charron (20) lakes. The standard gang sets produced nine species. The most numerous sport species was walleye, which comprised about 30% of the catch from each lake. A catch summary by gang is given in Appendices 3 and 4 for Sasaginnigak and Charron lakes respectively. A summary of the standard gang catch for each lake in terms of number of fish and biomass per mesh size is presented in Tables 5 and 6. The 7.62cm mesh produced the greatest number and biomass of sport species in Sasaginnigak and Charron lakes. The location of the standard gang sets are illustrated in Figs. 5 and 6.

Walleye Age and Growth

The walleye caught in the standard gang sets from Sasaginnigak Lake ranged in age from 3 to 21 years, with a modal age of 8 and a mean age of 8.9 years (Fig. 7, Table 7). The walleye captured from Charron Lake ranged from 5 to 20 years of age, with a modal age of 9 and a mean age of 10 years (Fig. 7, Table 7). In general, good representation of age groups between 10+ years and 20+ years would indicate a fairly low mortality rate.

The length-weight regressions for age-specific mean lengths and weights indicated positive allometric growth for Sasaginnigak walleye and negative allometric growth for Charron walleye (Fig. 8, Table 8). However, length-weight regressions using all walleye sampled showed positive allometric growth for both lakes (Table 8).

Table 4. Small fish collected from Sasaginnigak and Charron lakes.

Species	No. fish	
	Sasaginnigak	Charron
Yellow perch (Perca flavescens)	25	-
Spottail shiner (Notropis hudsonius)	50	7
Johnny darter (Etheostoma nigrum)	56	-
Walleye (Stizostedion vitreum)	8	-
Northern pike (Esox lucius)	4	1
Trout perch (Percopsis omiscomaycus)	4	-
Slimy sculpin (Cottus cognatus)	1	2
Log perch (Percina caprodes)	3	-
Burbot (Lota lota)	2	-
White sucker (Catostomus commersoni)	5	-
Bluntnose minnow (Pimphales notatus)	37	-
Emerald shiner (Notropis atherinoides)	45	-
Mimic shiner (Notropis volucellus)	35	-
Blacknose shiner (Notropis heterolepis)	14	12
Iowa darter (Etheostoma exile)	1	4
Brook stickleback (Culaea inconstans)	-	198

Table 5. Gill net summary of Sasaginnigak Lake.

Species		Mesh size (cm)							
		3.81	5.08	7.62	9.52	10.79	12.70	Total	%
Walleye (Stizostedion vitreum)	No.	25	66	50	23	12	3	179	34.4
	Kg.	7.9	22.1	27.5	19.2	16.9	4.9	98.5	
Northern pike (Esox lucius)	No.	11	11	29	9	5	1	66	12.7
	Kg.	22.4	11.7	39.1	15.5	9.5	2.4	100.6	
Yellow perch (Perca flavescens)	No.	4	4	1				9	1.7
	Kg.	0.2	0.3	0.2				0.7	
Whitefish (Coregonus clupeaformis)	No.				2	1	2	5	0.9
	Kg.				2.5	1.9	3.1	7.5	
Cisco (Coregonus artedii)	No.	123	66	23	14	2		228	43.8
	Kg.	4.8	8.4	6.8	4.9	0.9		25.8	
White sucker (Catostomus commersoni)	No.			4	11	7	3	25	4.8
	Kg.			3.4	8.4	10.4	4.8	27.0	
Shorthead redhorse (Moxostoma macrolepidotum)	No.		1		1	6	1	9	1.7
	Kg.		0.6		1.1	5.8	1.1	8.6	
Total	No.	163	148	107	60	33	10	521	
	Kg.	35.3	43.1	77.0	51.6	45.4	16.3	268.7	
Mean no. walleye/mesh		2.5	6.6	5.0	2.3	1.2	0.3		
Mean no. pike/mesh		1.1	1.1	2.9	0.9	0.5	0.1		
Mean no. fish/mesh		16.3	14.8	10.7	6.0	3.3	1.0	52.1	
Mean biomass/mesh		3.5	4.3	7.7	5.2	4.5	1.6	26.9	

Table 6. Gill net summary Charron Lake.

Species		Mesh size (cm)							
		3.81	5.08	7.62	9.52	10.79	12.70	Total	%
Walleye (*Stizostedion vitreum*)	No.	8	1	33	35	3	8	88	26.9
	Kg.	5.5	0.7	31.8	30.6	3.3	13.8	57.7	
Northern pike (*Esox lucius*)	No.	2	7	15	6	3	-	33	10.1
	Kg.	5.7	9.9	20.9	10.6	5.4	-	52.5	
Lake trout (*Salvelinus naymacush*)	No.	2	3	5	9	4	8	31	9.5
	Kg.	4.4	5.5	11.6	15.7	6.3	16.9	60.4	
Whitefish (*Coregonus clupeaformis*)	No.	1	13	21	11	15	17	78	23.8
	Kg.	0.08	7.1	12.9	9.5	14.5	23.3	67.4	
Cisco (*Coregonus artedii*)	No.	19	5	1	5	4	-	34	10.4
	Kg.	0.9	0.6	0.05	0.1	0.2	-	1.8	
Yellow perch (*Perca flavescens*)	No.	3	-	-	-	-	-	3	0.9
	Kg.	0.07	-	-	-	-	-	0.07	
White sucker (*Catostomus commersoni*)	No.	-	6	11	3	3	6	29	8.9
	Kg.	-	0.9	5.8	2.6	2.2	10.9	22.4	
Burbot (*Lota lota*)	No.	-	-	12	10	8	1	31	9.5
	Kg.	-	-	6.0	6.7	5.0	2.8	20.5	
Total	No.	35	35	98	79	40	40	327	
	Kg.	16.6	34.7	89.0	75.8	36.9	67.7	310.7	
Mean no. walleye/mesh		0.4	0.05	1.6	1.7	0.1	0.4		
Mean no. pike/mesh		0.1	0.4	0.7	0.3	0.1	-		
Mean no. fish/mesh		1.7	1.7	4.9	3.9	2.0	2.0	16.4	
Mean biomass/mesh		0.8	1.2	4.4	3.8	1.8	3.4	14.1	

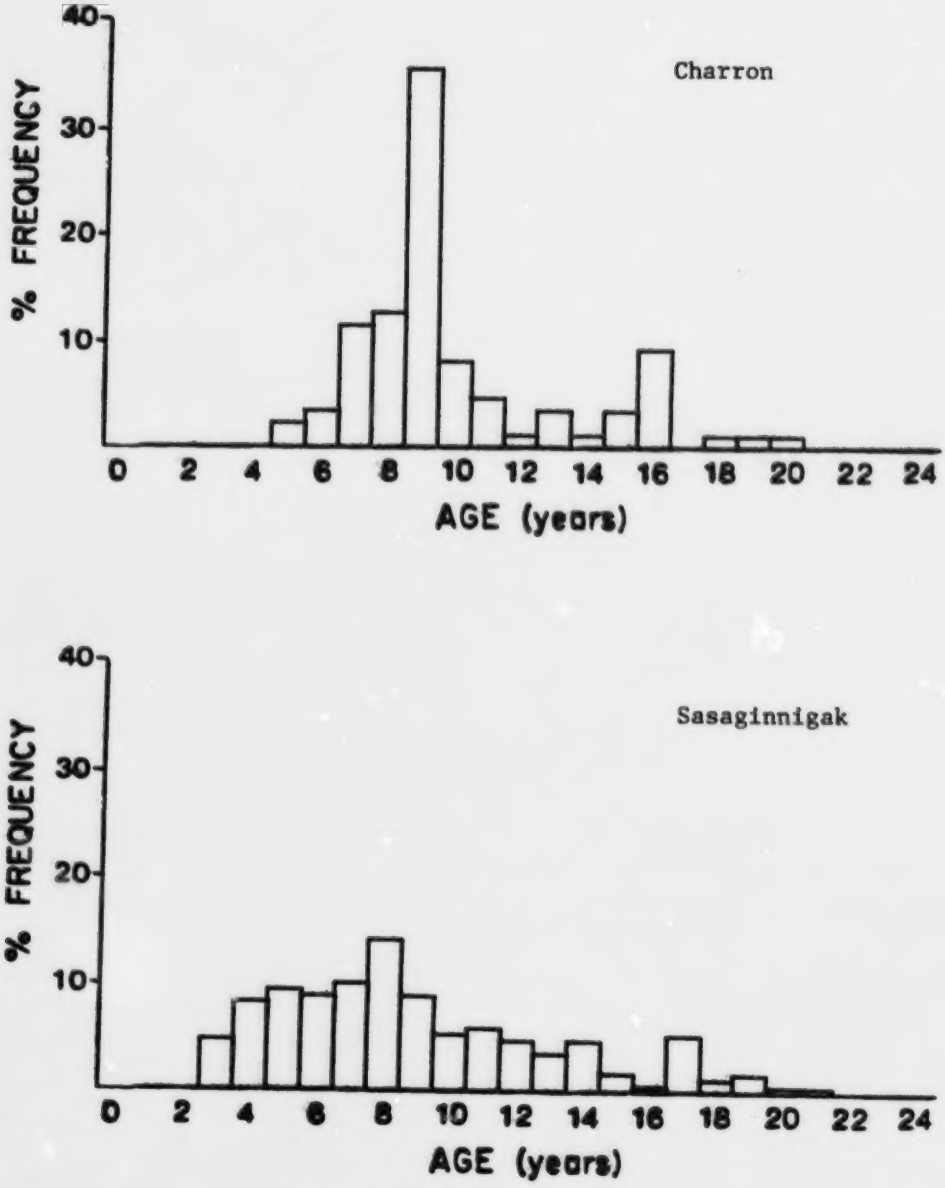


Fig.7 Age-frequency for Sasaginnigak and Charron walleye.

Table 7. Age-specific mean fork lengths, weights and condition factors for walleye from Sasaginnigak and Charron lakes.

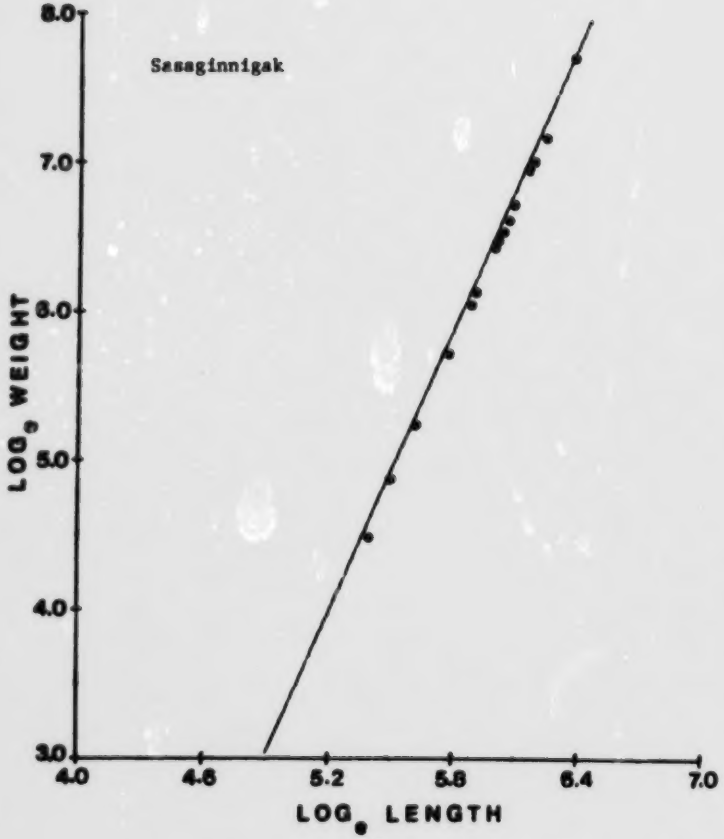
Age (yrs)	Sasaginnigak Number	Frequency (%)	Mean Length (mm)	Mean Weight (g)	Mean Condition Factor	Charron Number	Frequency (%)	Mean Length (mm)	Mean Weight (g)	Mean Condition Factor
3	8	4.71	220.25	95.00	0.87	-	-	-	-	-
4	14	8.24	244.64	140.00	0.90	-	-	-	-	-
5	16	9.41	273.00	203.13	0.95	2	2.30	378.00	600.00	1.10
6	15	8.82	321.60	324.67	0.96	3	3.45	350.00	460.00	1.07
7	17	10.00	359.06	457.06	0.97	10	11.49	424.20	792.00	1.04
8	24	14.12	364.42	493.33	0.99	10	12.64	446.40	902.00	1.00
9	15	8.82	403.60	672.33	0.98	31	35.63	438.26	862.26	1.01
10	9	5.29	427.33	803.89	0.98	7	8.05	427.43	843.29	1.07
11	10	5.88	408.40	694.50	0.98	4	4.60	474.50	1160.00	1.06
12	8	4.71	475.50	1127.50	1.01	1	1.15	564.00	1860.00	1.04
13	6	3.53	403.67	667.50	1.01	3	3.45	540.00	1653.33	1.05
14	8	4.71	440.50	892.50	1.00	1	1.15	462.00	1100.00	1.12
15	3	1.76	420.00	736.67	0.98	3	3.45	504.00	1320.00	1.02
16	1	0.59	360.00	460.00	0.99	8	9.20	534.25	1692.00	1.10
17	9	5.29	488.67	1188.89	0.98	-	-	-	-	-
18	2	1.18	590.50	2400.00	1.11	1	1.15	460.00	960.00	0.99
19	3	1.76	515.33	1400.00	1.00	1	1.15	496.00	1300.00	1.07
20	1	0.59	406.00	700.00	1.05	1	1.15	480.00	1200.00	1.09
21	1	0.59	418.00	740.00	1.01					
Total	170					86				
Mean			367.78	580.53	0.97			451.81	995.47	1.04

The slope of the length-weight curves for walleye from Sasaginnigak and Charron lakes were the same ($F = 2.73$, 1 and 30 d.f., $P \geq 0.05$). There also was no significant difference between the elevation of the length-weight curves for Sasaginnigak and Charron walleye ($F = 0.22$, 1 and 31 d.f., $P \geq 0.05$).

Walford plots for walleye from Sasaginnigak and Charron lakes (Fig. 9) showed the relationship of L_{t+1} and ℓ_t to be significant for Sasaginnigak walleye and not significant for Charron walleye (Table 9). The L_∞ for Sasaginnigak walleye (472mm) is low, as 11.8% of the walleye captured in Sasaginnigak were greater than 472mm in length. This is probably due to differential growth rates within year classes and between age classes resulting in wide variances of mean length within each age class.

The Von Bertalanffy curves had higher correlation coefficients than the exponential curves (Figs. 10, 11; Tables 10, 11). The regressions of $\text{Log}_e (L_\infty - \ell_t)$ on t are shown in Fig. 12.

The maturity data for walleye from Sasaginnigak and Charron lakes (Table 12) showed the mean age at onset of sexual maturity to be 8.6 years and 7.0 years respectively. The age at 100% maturity was 12.0 years for both lakes. The incidence of fish identified as immature beyond age 12 was probably due to alternate year spawners that were not developing for the following year. Because the walleye were captured in late June and July there would have been some difficulty identifying the 1979 spawners since, in



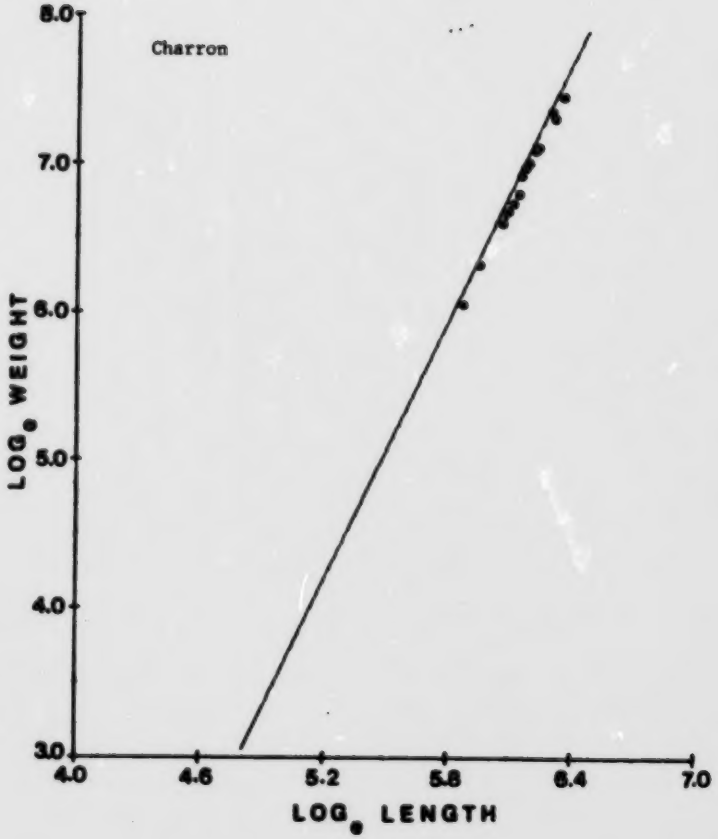


Fig.8 Length-weight regressions for walleye from Sasaginnigak and Charron lakes.

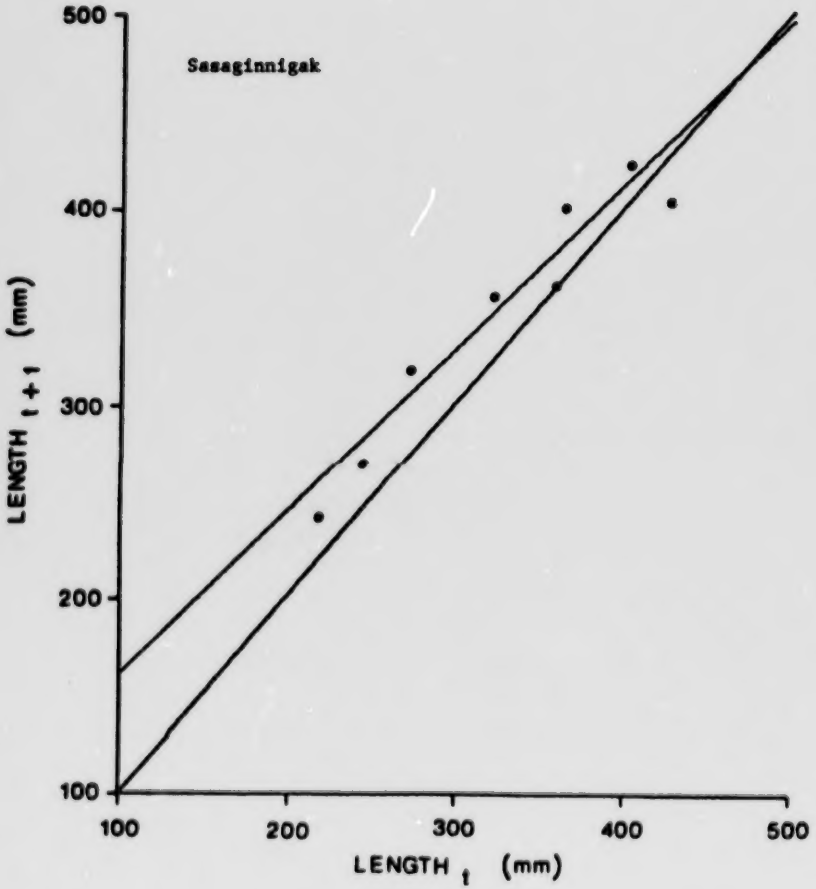
Table 8. Length-weight regressions for walleye from Sasaginnigak and Charron lakes.

Lake	Length-weight equation	Correlation coefficient	Test F value	d.f.
Sasaginnigak[a]	Log_e weight = -12.526 + 3.173 Log_e length	0.999	13687.50*	1,17
Sasaginnigak[b]	Log_e weight = -13.025 + 3.248 Log_e length	0.990	8797.38*	1,175
Charron[a]	Log_e weight = -11.248 + 2.966 Log_e length	0.995	1485.38*	1,13
Charron[b]	Log_e weight = -11.630 + 3.025 Log_e length	0.997	1782.49*	1,85

a - calculated using age-specific mean lengths and weights

b - calculated using all walleye sampled

* Significant at $P \geq 0.05$



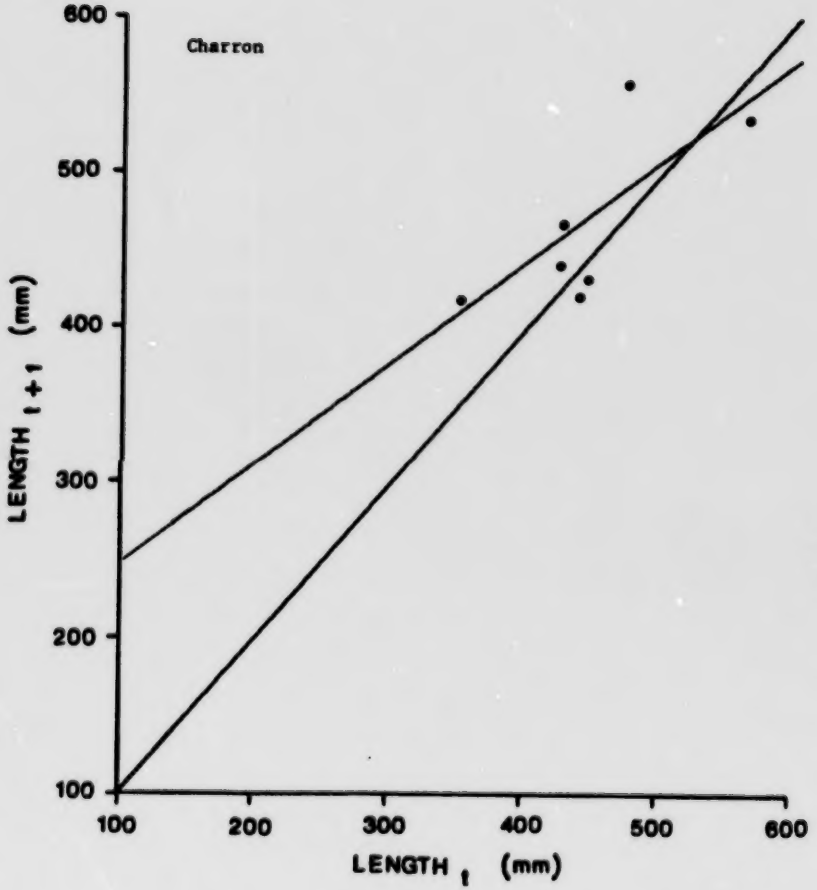


Fig.9 Walford plots of walleye from Sasaginnigak and Charron lakes.

Table 9. Linear equations of Walford plots for walleye from Sasaginnigak and Charron lakes.

Lake	Equation	L_∞	Correlation coefficient	Test F value	d.f.
Sasaginnigak	$Log_e L_{t+1} = 75.941 + 0.839\ Log_e L_t$ [a]	472	0.960	71.16*	1,6
Charron	$Log_e L_{t+1} = 182.957 + 0.651\ Log_e L_t$ [b]	523	0.738	5.98	1,5

a = Ages 3-11
b = Ages 6-13
* Significant at $P \geq 0.05$

many cases, the residual eggs would have been resorbed (Olynyk 1980).

Northern Pike Age and Growth

The northern pike captured in Sasaginnigak ranged in age from 3 to 14 years (Fig. 13, Table 13). Mean age of the sample was 5.8 years and the modal age was 5 years. Charron Lake pike ranged in age from 2 to 10 years with a mean age of 6.5 years and a modal age of 7 years (Fig. 13, Table 13).

Length-weight regressions using age-specific mean lengths and weights for Sasaginnigak and Charron northern pike indicated positive allometric growth (Fig. 14, Table 14). However, length-weight regressions using all fish captured indicated negative allometric growth for both lakes (Table 14).

Analysis of covariance of the length-weight regressions indicated a significant difference in the slope of the curves ($F = 8.24$, 1 and 15 d.f., $P \geq 0.05$), but no significant difference in elevation of the curves ($F = 0.26$, 1 and 16 d.f., $P > 0.05$).

The estimate of L_∞ was greater for Sasaginnigak pike (748mm) than for Charron pike (662mm). The relationship of L_{t+1} and ℓ_t was significant in both cases (Table 15). The Walford plots for Sasaginnigak and Charron pike are presented in Fig. 15.

A comparison of exponential growth curves (Fig. 16) to Von Bertalanffy growth curves (Fig. 17) for Sasaginnigak and Charron pike indicated a higher correlation coefficient for the Von Bertalanffy curve for Sasaginnigak pike (Table 16). Charron pike had

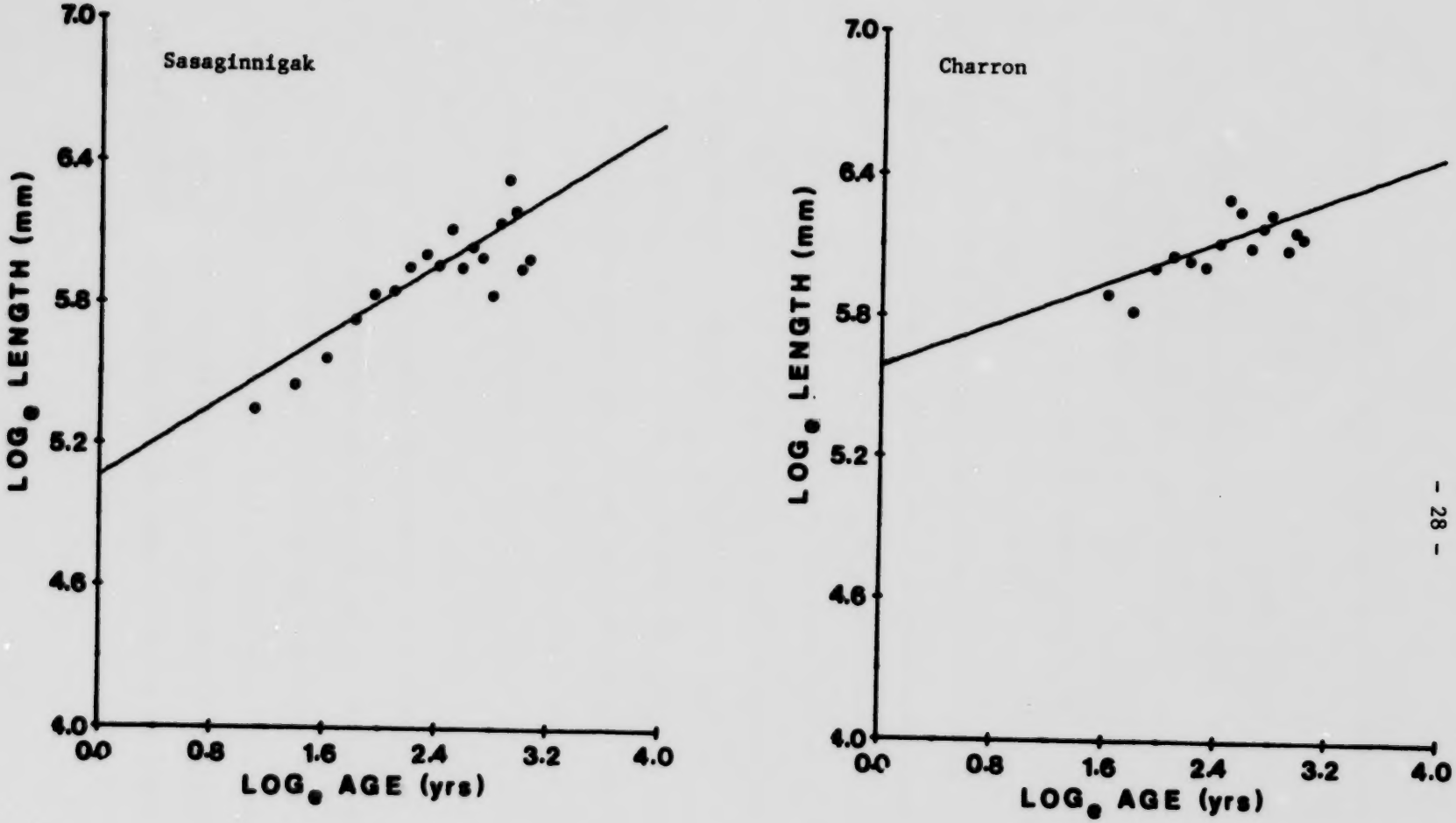
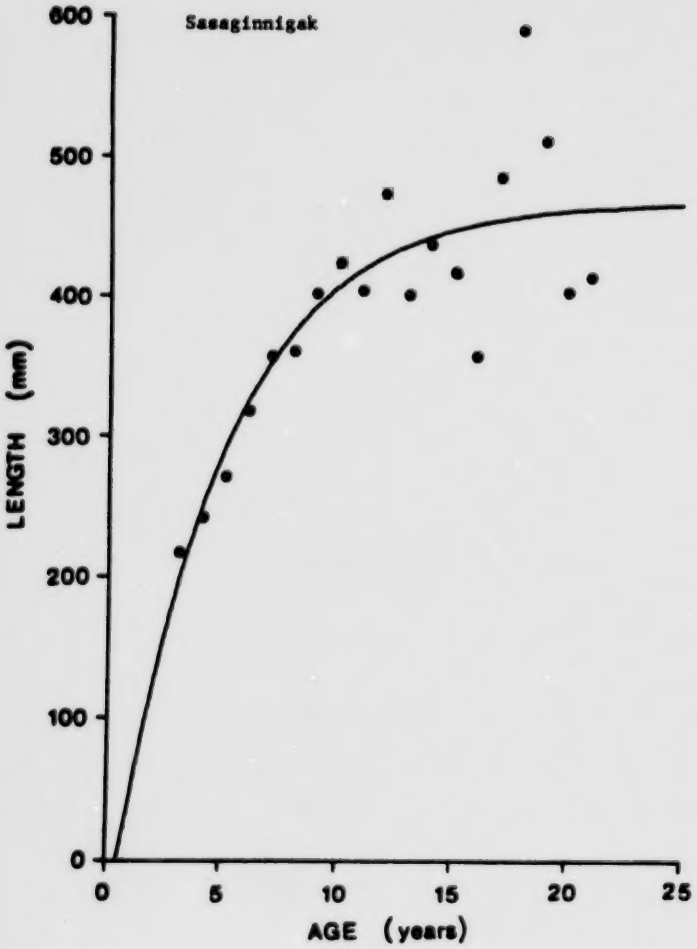


Fig.10 Exponential growth curves for walleye from Sasaginnigak and Charron lakes.



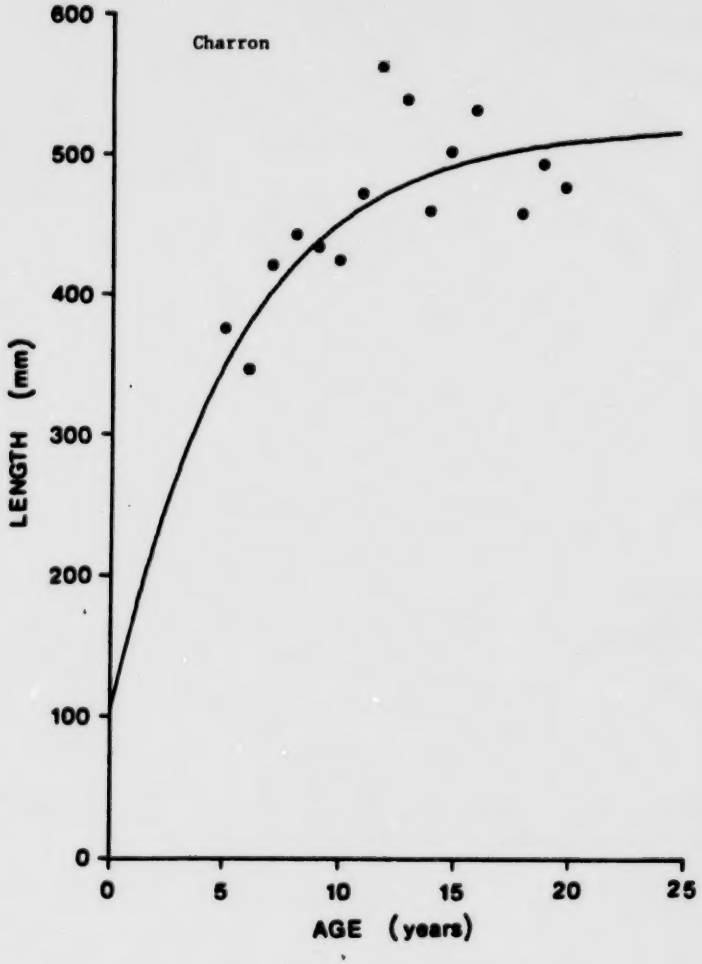


Fig.11 von Bertalanffy growth curves for walleye from Sasaginnigak and Charron lakes.

Table 10. Exponential growth curves for walleye from Sasaginnigak and Charron lakes.

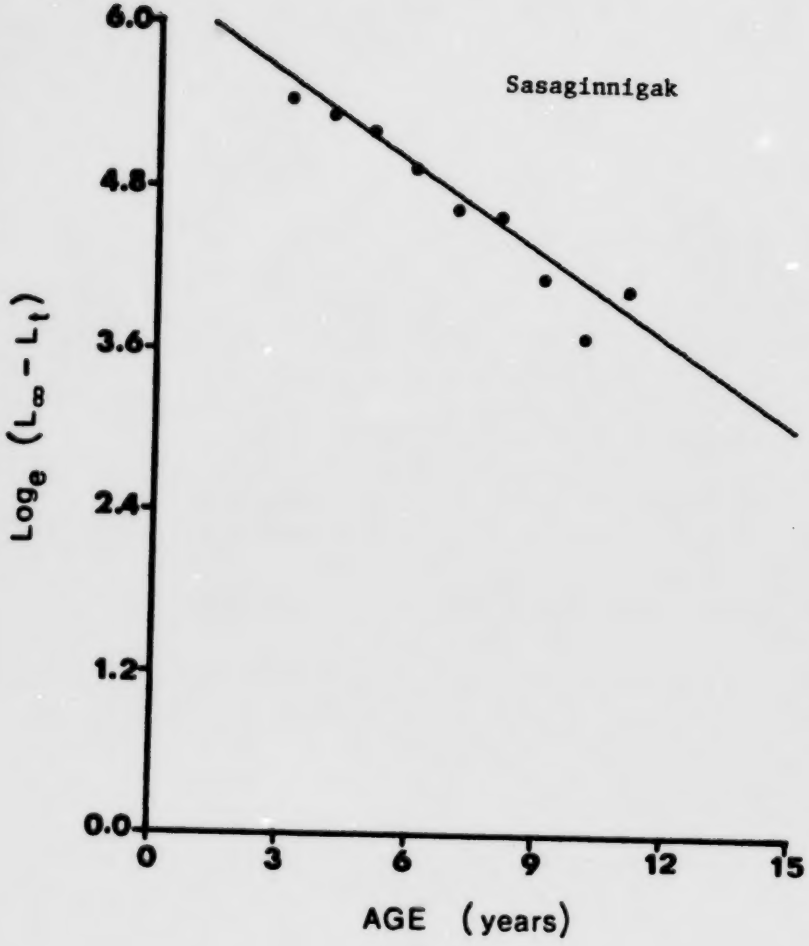
Lake	Log_e length = atb.Log_e age	Age range (years)	Correlation coefficient	Test F ratio and d.f.
Sasaginnigak	Log_e length = 5.064 + 0.379 Log_e age	3.21	0.872	54.02* (1,17)
Charron	Log_e length = 5.587 + 0.226 Log_e age	5.20	0.747	16.42* (1,13)

*significant at $P \geq 0.05$.

Table 11. Relationships of $Log_e(L_\infty - L_t)$ and t for walleye from Sasaginnigak and Charron lakes.

Lake	$Log_e(L_\infty - l_t) = a-bt$	Correlation coefficient	Test F ratio and d.f.
Sasaginnigak	$Log_e\ (472-l_t) = 6.254 - 0.213_t$ [a]	-0.962	86.46 (1,7)
Charron	$Log_e\ (523-l_t) = 6.034 - 0.180_t$ [b]	-0.826	8.62 (1,4)

a = Ages 3-11
b = Ages 6-13



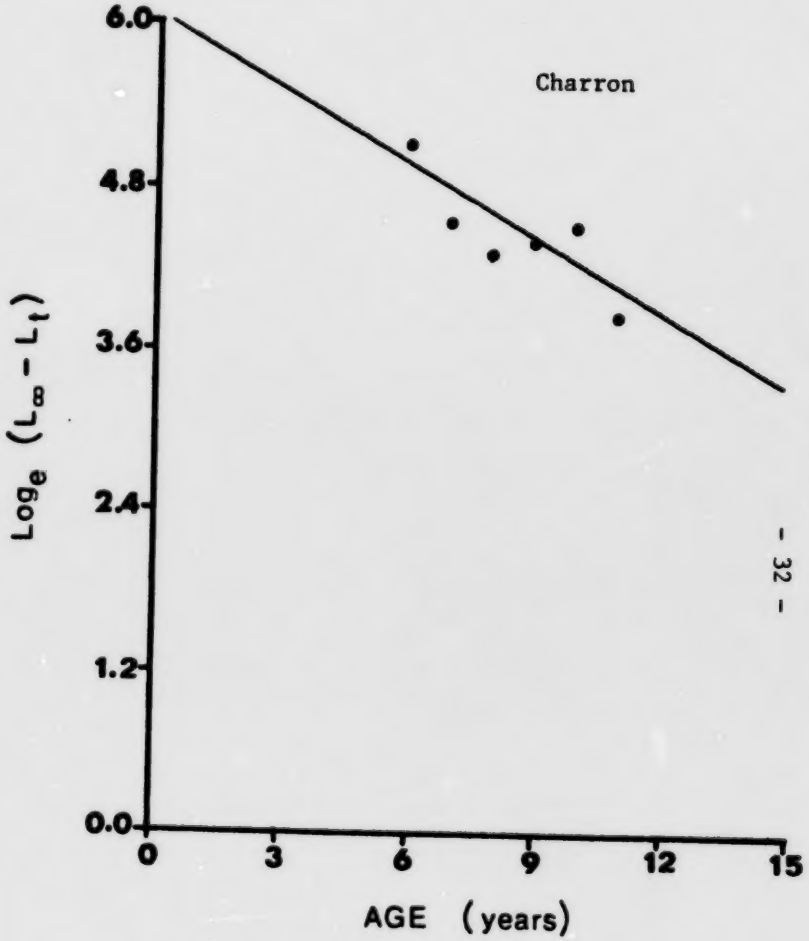


Fig.12 Regressions of $Log_e (L_\infty - 1_t)$ on t for walleye from Sasaginnigak and Charron lakes.

Table 12. Maturity data for walleye from Sasaginnigak and Charron lakes.

	Sasaginnigak	Charron
Sex ratio (males to females)	1:2.21	1:2.18
Percent males mature	33.9	40.7
Mean length mature males (mm)	396	460
Percent females mature	51.3	88.1
Mean length mature females (mm)	446	468
Mean age of maturity (Z)	8.6	7
Age at 100% maturity	12	12
Mean length at 100% maturity (mm)	475	564
Mean age of sample	8.9	10.0

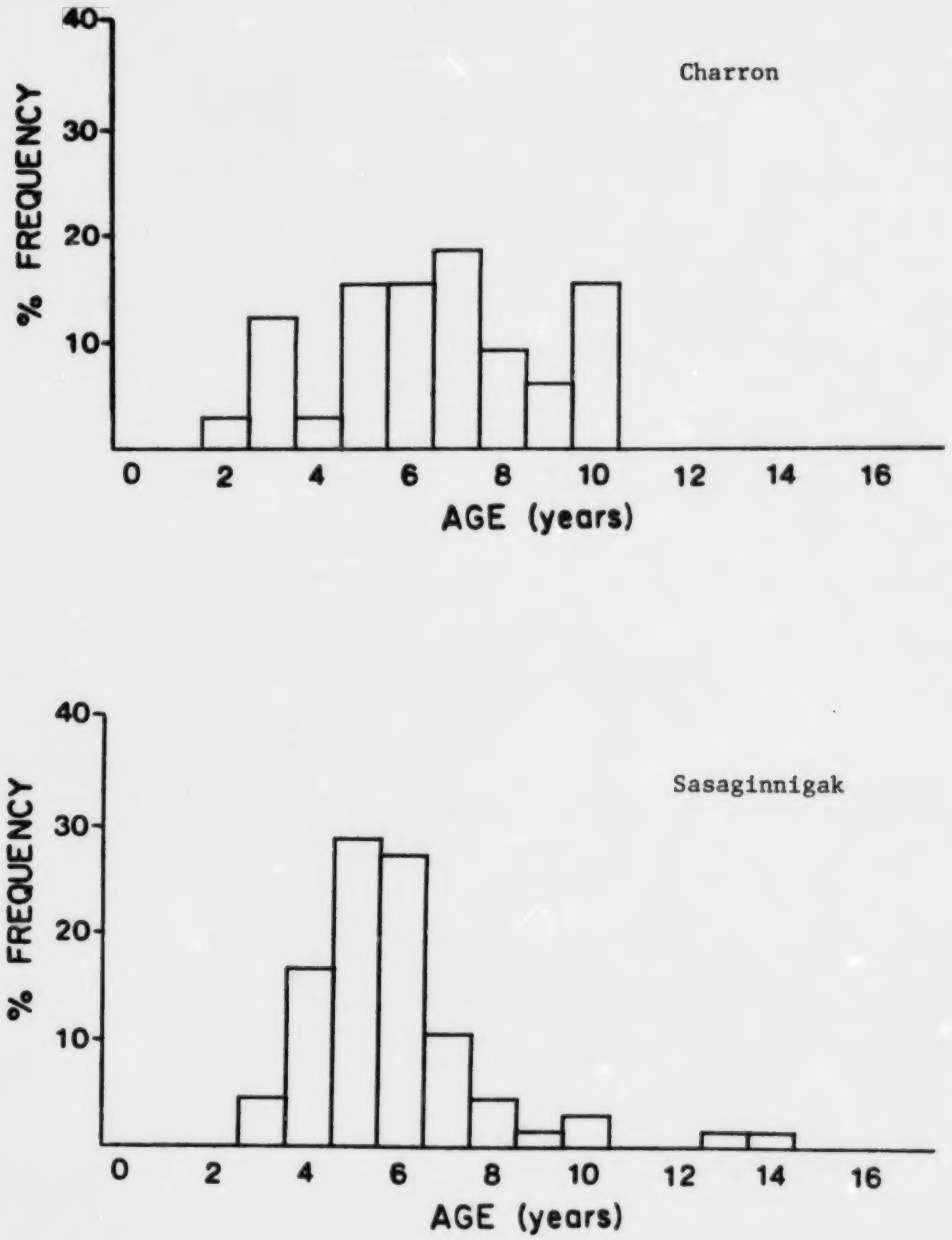


Fig.13 Age-frequency for Sasaginnigak and Charron northern pike.

Table 13. Age-specific mean fork lengths, weights and condition factors for northern pike from Sasaginnigak and Charron lakes.

	Sasaginnigak					Charron				
Age (yrs)	Number	Frequency (%)	Mean Length (mm)	Mean Weight (g)	Mean Condition Factor	Number	Frequency (%)	Mean Length (mm)	Mean Weight (g)	Mean Condition Factor
2						1	3.13	350.00	290.00	0.63
3	3	4.55	404.00	453.33	0.69	4	12.50	492.75	765.00	0.63
4	11	16.67	500.55	818.64	0.63	1	3.13	654.00	1780.00	0.64
5	19	28.79	552.11	1199.47	0.73	5	15.63	588.80	1340.00	0.63
6	18	27.27	622.83	1629.72	0.65	5	15.63	617.60	1576.00	0.65
7	7	10.61	633.14	1634.29	0.63	6	18.75	651.00	1731.67	0.63
8	3	4.55	674.00	2033.33	0.66	3	9.38	686.00	2486.67	0.75
9	1	1.52	820.00	3740.00	0.68	2	6.25	651.00	1680.00	0.61
10	2	3.03	735.00	2600.00	0.65	5	15.63	697.00	2342.00	0.65
11										
12										
13	1	1.52	696.00	2300.00	0.68					
14	1	1.52	1080.00	9350.00	0.74					
Total	66					32				
Mean			589.98	1524.55	0.67			617.53	1644.69	0.65

a higher correlation coefficient for the exponential curve (Table 17). The regressions of $Log_e (L_\infty - \ell_t)$ on t are shown in Fig. 18.

Maturity data for northern pike from Sasaginnigak and Charron lakes (Table 18) showed the mean age at onset of sexual maturity to be 3.8 and 3.2 years respectively. The age at 100% maturity was 4 years in Charron Lake and 6 years in Sasaginnigak Lake.

Lake Trout Age and Growth

The lake trout captured in the standard gang sets from Charron Lake ranged in age from 6 to 19 years, with a modal age of 8 years and a mean age of 10.2 years (Fig. 19, Table 19).

Length-weight regressions using age-specific mean lengths and weights and using all lake trout sampled indicated positive allometric growth (Fig. 20, Table 20).

The exponential growth model was the only one that gave a significant relationship of length to age (Fig. 21, Table 21). Attempts at fitting the Von Bertalanffy model were unsuccessful. This was probably due to the small sample size.

The maturity data for lake trout from Charron Lake showed the mean age at onset of sexual maturity to be 7.6 years. The age at 100% maturity was 9.0 years (Table 22).

Stomach Contents

The analysis of the stomach contents of walleye and northern pike from Sasaginnigak and Charron lakes indicated fish remains to

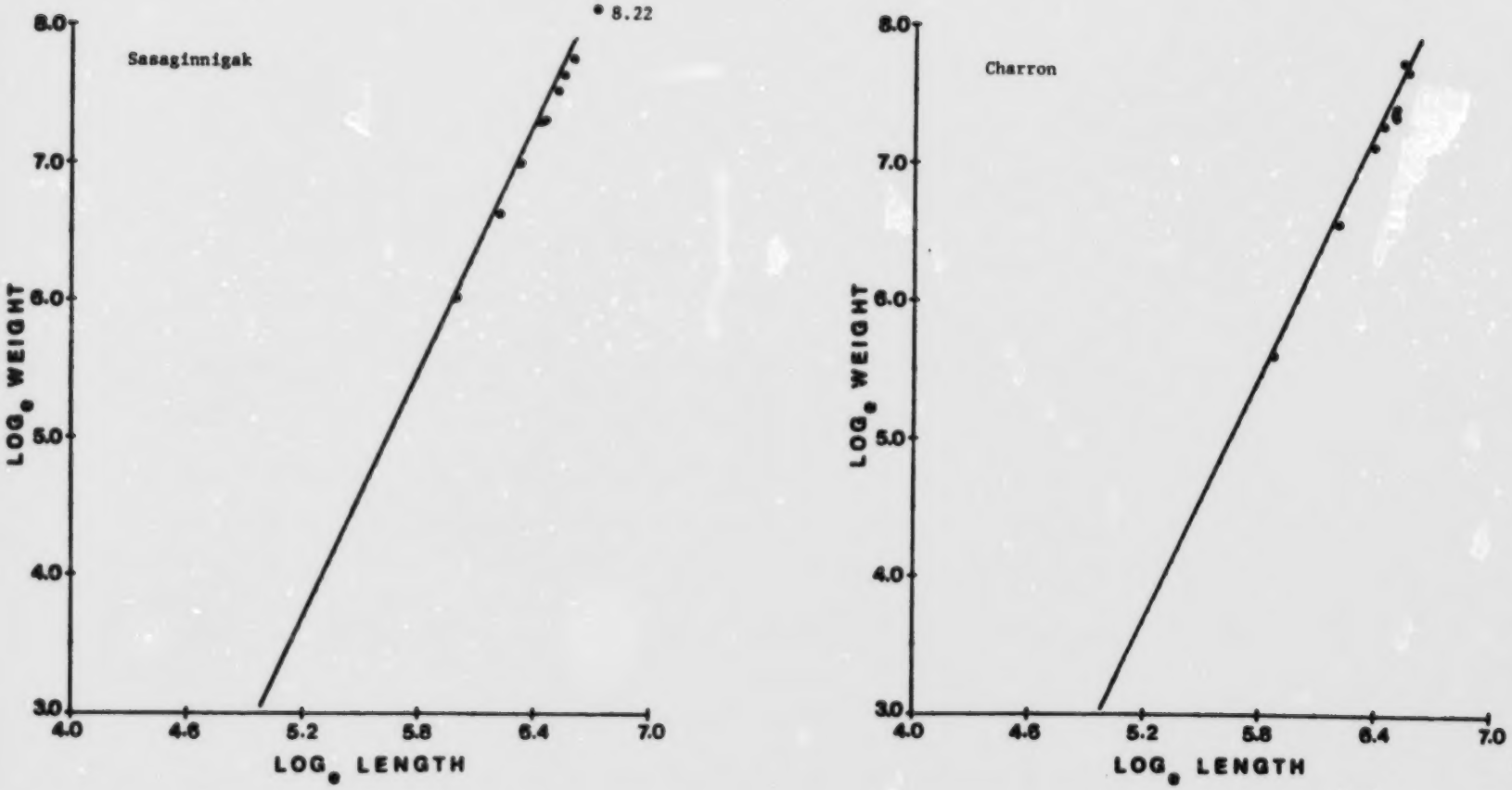


Fig.14 Length-weight regressions for northern pike from Sasaginnigak and Charron lakes.

Table 14. Length-weight regressions for northern pike from Sasaginnigak and Charron lakes.

Lake	Length-weight equation	Correlation coefficient	Test F value	d.f.
Sasaginnigak [a]	$Log_e weight = -12.272 + 3.057\ Log_e length$	0.999	3450.78*	1,8
Sasaginnigak [b]	$Log_e weight = -10.778 + 2.820\ Log_e length$	0.953	635.89*	1,64
Charron [a]	$Log_e weight = -12.046 + 3.019\ Log_e length$	0.995	658.41*	1,7
Charron [b]	$Log_e weight = -11.827 + 2.980\ Log_e length$	0.876	596.70*	1,30

a calculated using age-specific mean lengths and weights

b calculated using all lengths and weights

* significant at $P \geq 0.05$

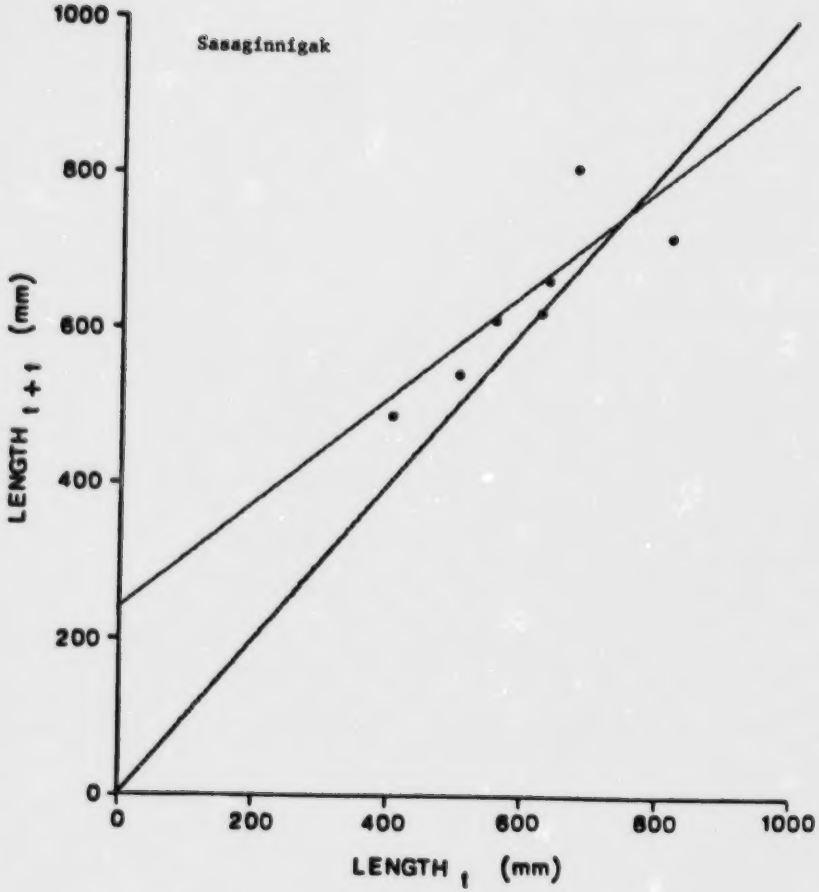
Table 15. Linear equations of Walford plots for northern pike from Sasaginnigak and Charron lakes.

Lake	Equation	L_∞	Correlation coefficient	Test F value	d.f.
Sasaginnigak	$\text{Log}_e L_{t+1} = 240.211 + 0.679\ \text{Log}_e l_t$ [a]	748	0.838	11.81*	1,5
Charron	$\text{Log}_e L_{t+1} = 377.397 + 0.430\ \text{Log}_e l_t$ [b]	662	0.742	7.35*	1,6

a Ages 3-10

b Ages 3-10

* Significant $P \geq 0.05$



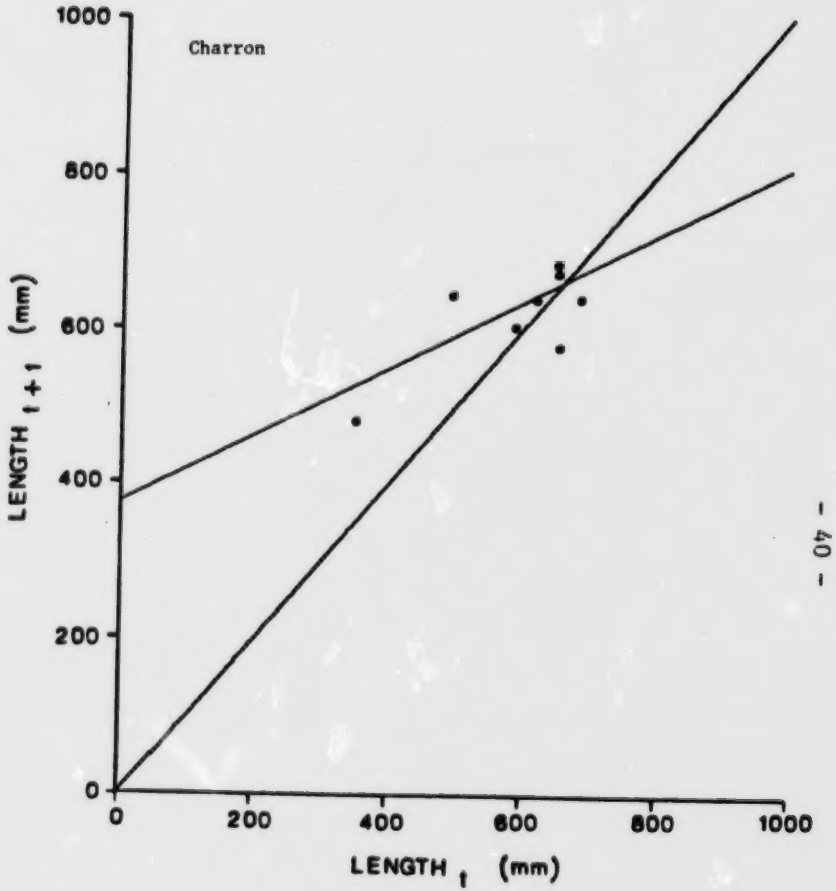
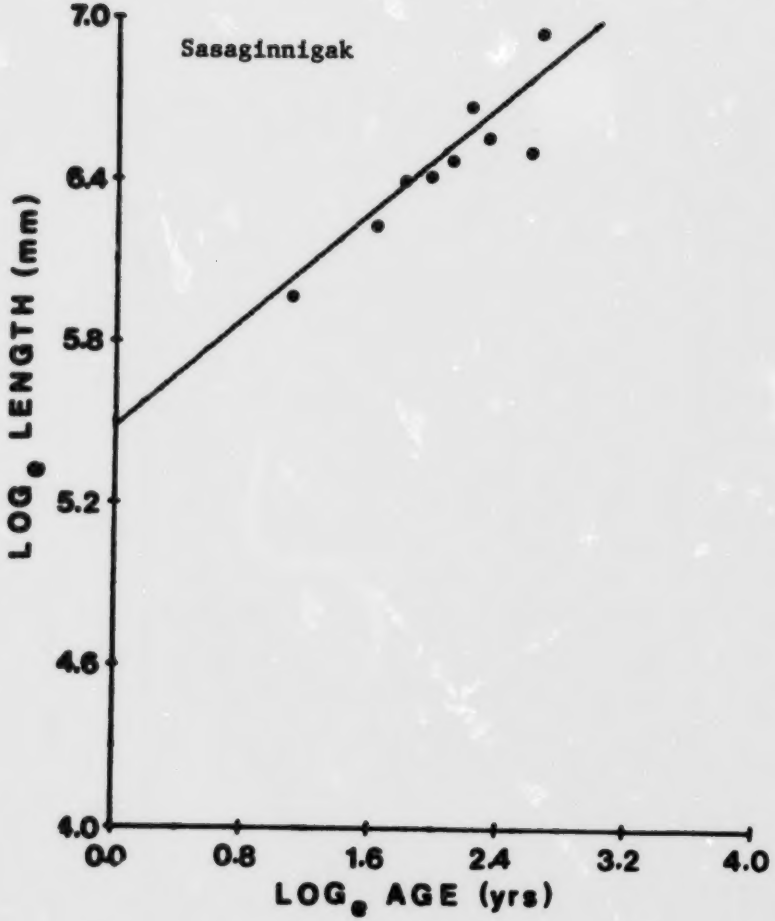


Fig.15 Walford plots of northern pike from Sasaginnigak and Charron lakes.



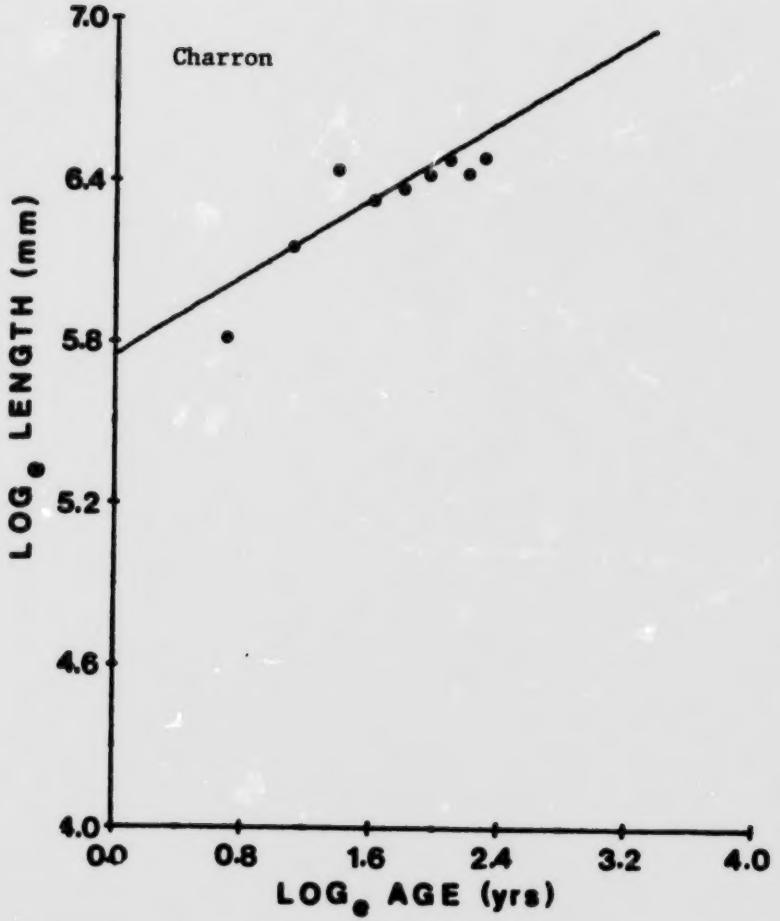
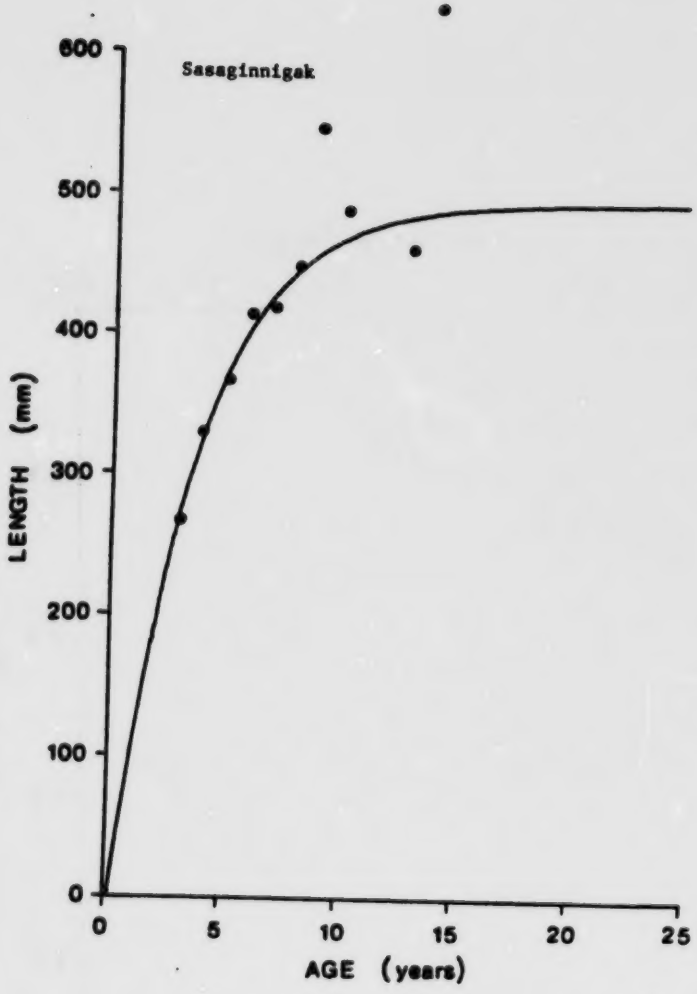


Fig.16 Exponential growth curves for northern pike from Sasaginnigak and Charron lakes.



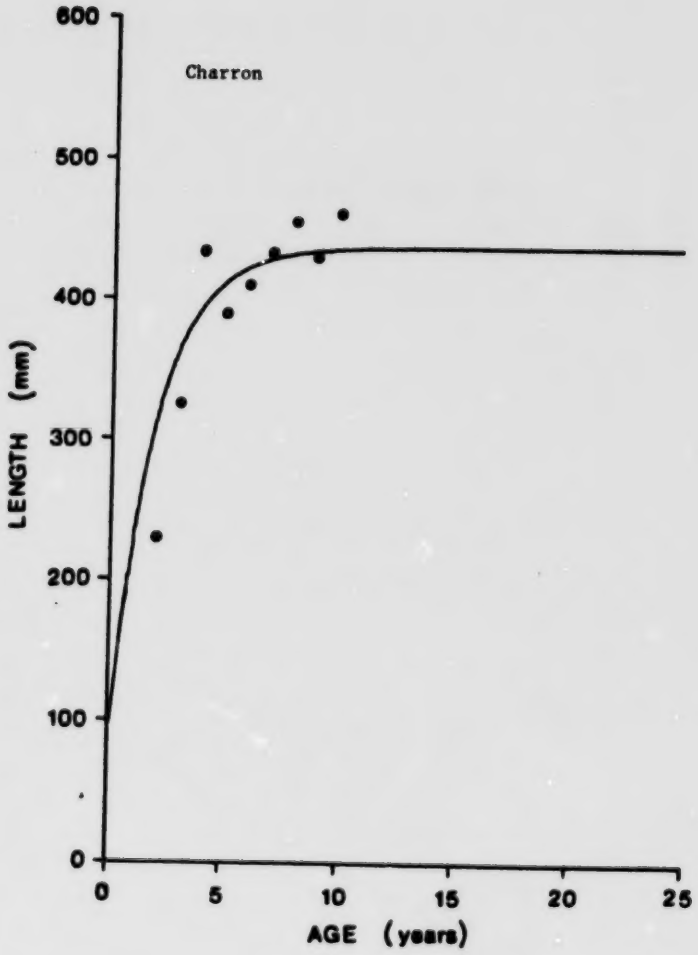


Fig.17 von Bertalanffy growth curves for northern pike from Sasaginnigak and Charron lakes.

Table 16. Relationships of $Log_e(L_\infty - l_t)$ and t for northern pike from Sasaginnigak and Charron lakes.

Lake	$Log_e(L_\infty - l_t) = a-bt$	Correlation coefficient	Test F ratio and d.f.
Sasaginnigak	$Log_e(748-l_t) = 6.724-0.298t$ [a]	-0.992	237.29 (1,4)
Charron	$Log_e(662-l_t) = 6.288-0.528t$ [b]	-0.677	3.38 (1,4)

a Ages 3-10

b Ages 3-10

Table 17. Exponential growth curves for northern pike from Sasaginnigak and Charron lakes.

Lake	Log_e length = a+b.Log_e age	Age range years	Correlation coefficient	Test F ratio and d.f.
Sasaginnigak	Log_e length = 5.480 + 0.505 Log_e age	3-14	0.919	43.72* (1,8)
Charron	Log_e length = 5.765 + 0.364 Log_e age	2-10	0.886	25.50* (1,7)

* Significant at $P \geq 0.05$

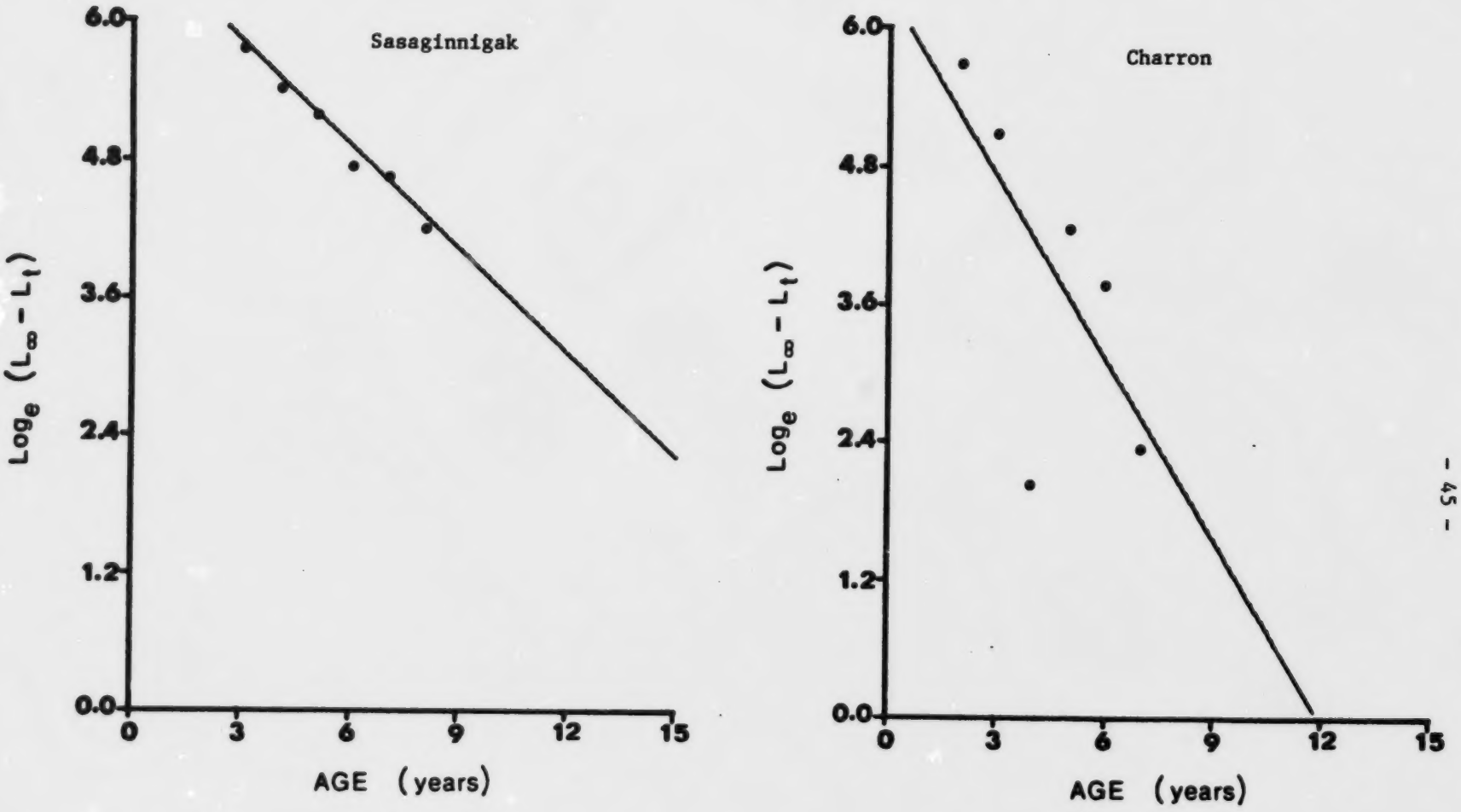


Fig.18 Regressions of $Log_e (L_\infty - 1_t)$ on t for northern pike from Sasaginnigak and Charron lakes.

Table 18. Maturity data for northern pike from Sasaginnigak and Charron lakes.

	Sassiginnigak	Charron
Sex ratio (males to females)	1:1.64	1:1.28
Percent males mature	84.0	78.6
Mean length mature males (mm)	559	601
Percent females mature	100.0	100.0
Mean length mature females (mm)	619	654
Mean age at maturity (Z)	3.8	3.2
Age at 100% maturity	6	4
Mean length at 100% maturity (mm)	623	654
Mean age of sample	5.8	6.5

Table 19. Age-specific mean fork lengths, weights and condition factors for lake trout from Charron Lake.

Age (yrs)	Number Caught	Frequency (%)	Mean Length (mm)	Mean Weight (g)	Mean Condition Factor
6	3	9.68	471.33	1213.33	1.16
7	6	19.35	481.67	1270.00	1.12
8	7	22.58	508.57	1650.00	1.18
9	2	6.45	578.00	2290.00	1.17
10	2	6.45	633.00	3290.00	1.28
11	1	3.23	508.00	1620.00	1.24
12	1	3.23	606.00	2480.00	1.11
13	2	6.45	600.00	2640.00	1.16
14	2	6.45	600.00	2510.00	1.15
15	2	6.45	578.00	2770.00	1.46
16					
17	1	3.23	540.00	2169.00	1.38
18	1	3.23	570.00	2200.00	1.19
19	1	3.23	562.00	2240.00	1.26
Total	31				
Mean			536.39	1952.23	1.19

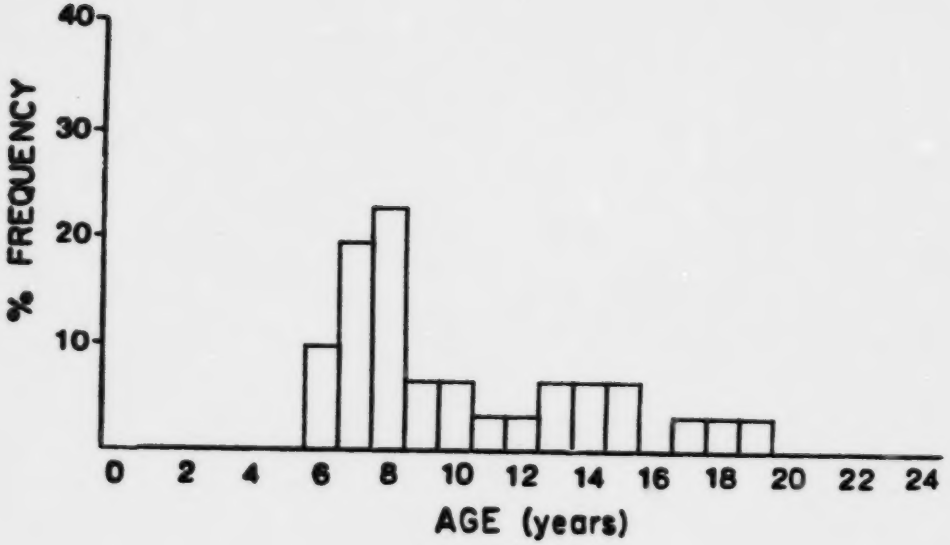


Fig. 19 Age-frequency for Charron lake trout.

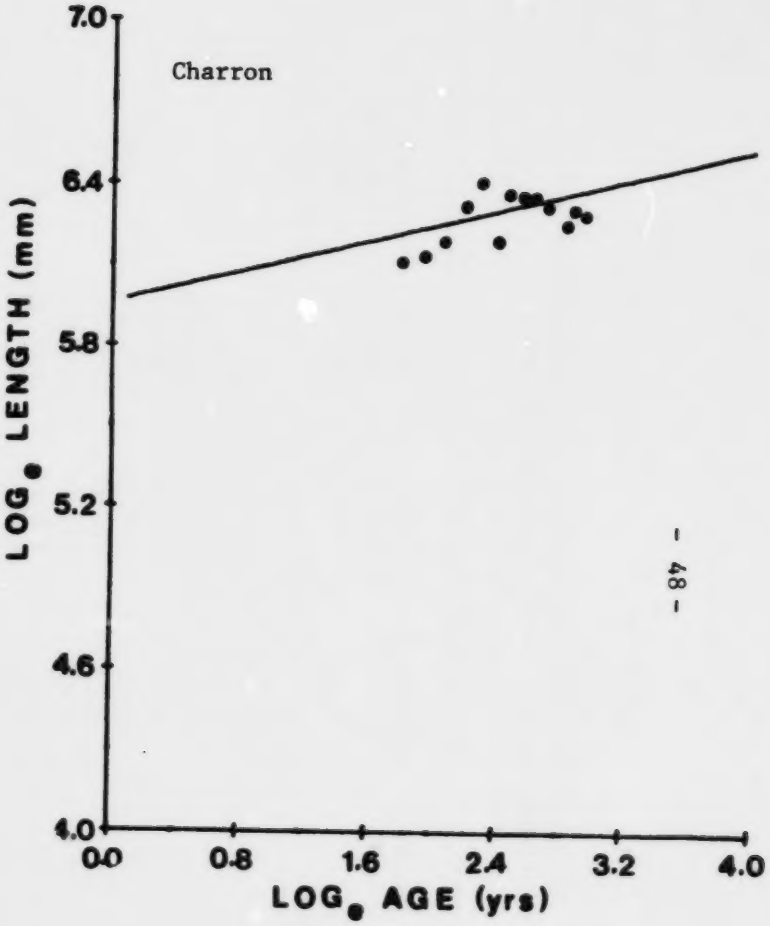


Fig. 21 Exponential growth curves for lake trout from Charron Lake.

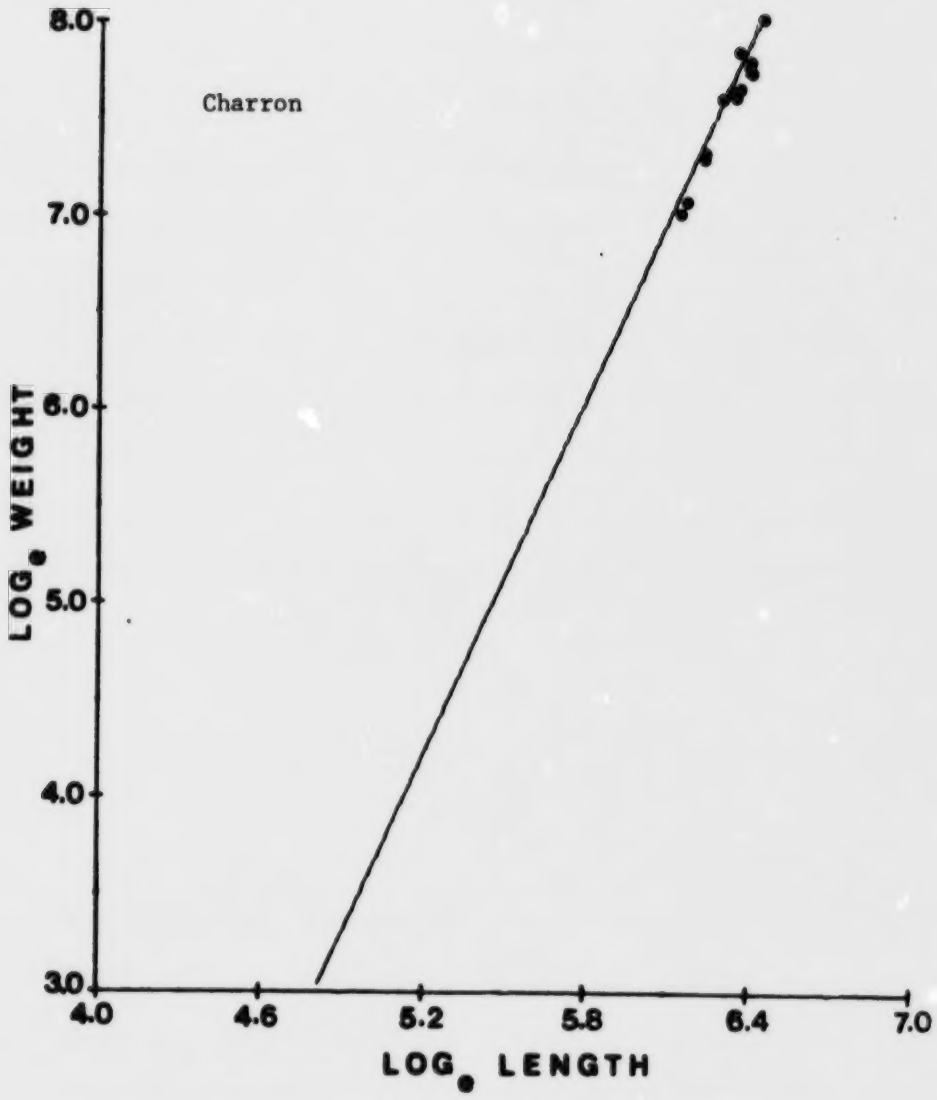


Fig. 20 Length-weight regression for lake trout from Charron Lake.

be the most prevalent diet item. Of the identifiable remains ciscoes were the most numerous (Table 23). The same was true for the lake trout from Charron Lake.

Production Potential

The morphometric and edaphic properties of Sasaginnigak and Charron lakes were employed to provide an estimate of the maximum sustained yield (MSY) using the morphoedaphic index (MEI) described by Ryder (1965). Derived potential yields are given in Table 24. The MEI for Sasaginnigak falls in the eutrophic range and the MEI for Charron is in the oligotrophic range according to the scale devised by Adams and Olver(1977). The trophic state of the lakes as determined by the trophic state index (TSI) described by Carlson (1977) indicated both to be mesotrophic (Table 25).

DISCUSSION

Morphometry

Sasaginnigak and Charron lakes exhibit typical Precambrian Shield morphometry. The shoreline of these lakes is predominantly rock with few sand beaches or flooded marshes. Sand beaches and shallow areas of rooted vegetation are important nursery and feeding areas for minnows and young-of-the-year yellow perch (Schupp 1978, Clady and Nielson 1978). The absence of flooded marshes may be

Table 20. Length-weight regression for lake trout from Charron Lake.

Length-weight equation	Correlation coefficient	Test F value	d.f.
Log_e weight = -12.039 + 3.116 Log_e length [a]	.970	176.60 *	1,11
Log_e weight = -13.621 + 3.363 Log_e length [b]	.961	346.01 *	1,29

a calculated using age-specific mean lengths and weights

b calculated using all lake trout sampled

* Significant at $P \geq 0.05$.

Table 21. Exponential growth curve for lake trout from Charron Lake.

Log_e length = a+b.Log_e age	Age range years	Correlation coefficient	Test F ratio and d.f.
Log_e length = 5.966 + 0.144 Log_e age	6-19	0.564	5.14* (1,11)

* Significant at $P \geq 0.05$

Table 22. Maturity data for lake trout from Charron Lake.

Sex ratio (males to females)	1:0.63
Percent males mature	73.7
Mean length mature males (mm)	555
Percent females mature	83.3
Mean length mature females (mm)	558
Mean age at maturity (Z)	7.6
Age at 100% maturity	9
Mean length at 100% maturity (mm)	578
Mean age of sample	10.2

Table 23. Stomach contents of walleye, lake trout and northern pike from Sasaginnigak and Charron lakes.

	Sasaginnigak		Charron		
	Walleye %	N. pike %	Walleye %	Lake trout %	N. pike %
Number examined	179	66	88	31	33
Empty	70	45	23	8	28
Fish					
Cisco	2.2	12.1	6.8	45.2	3.0
Johnny darter	0.5	-	-	-	-
Walleye	1.1	-	-	-	-
Slimy sculpin	-	-	2.3	-	-
Brook stickleback	-	-	2.3	-	-
Whitefish	-	-	-	3.2	-
Unidentified fish remains	25.1	10.6	59.1	25.8	6.1
Invertebrates					
Ephmeroptera	22.3	1.5	6.8	-	-
Diptera	-	-	1.1	-	-
Trichoptera	-	-	1.1	-	-
Amphipoda	4.5	-	1.1	-	-
Decapoda	-	12.1	-	-	3.0
Unidentified invertebrate remains	8.9	1.5	-	-	-

limiting the abundances of yellow perch and northern pike. Yellow perch characteristically spawn over submerged vegetation and brush (Ney 1978) and pike characteristically spawn over flooded marsh vegetation and flat meadows covered by spring flood waters (Toner and Lawler 1969). There were not many northern pike captured in these lakes and even fewer yellow perch.

The limited amount of these habitat types may also have an effect on the abundance of walleye in these lakes. Young-of-the-year yellow perch have been shown to be the preferred diet item of walleye in many lakes in the northern and central regions of walleye distribution (Colby et al. 1979). Prey abundance has been shown to have an effect on walleye recruitment and growth (Forney 1977). Since there were very few yellow perch found in Sasaginnigak and Charron lakes, cisco was the dominant diet item of walleye, lake trout and northern pike.

It has been reported by Johnson et al. (1977) that there is a greater chance for success of walleye in large, low MEI lakes which have an association of walleye, lake trout and pike, such as Charron, than in small, low MEI lakes which have an association of just walleye and pike. In general, large lakes such as Sasaginnigak and Charron have more diverse habitat of which some is likely to be suitable for walleye and the magnitude of these areas is likely to be equal to or greater than suitable habitat areas in smaller lakes of similar morphometry.

Table 24. MEI and estimated production potential (MSY) for Sasaginnigak and Charron lakes.

Lake	Mean depth (m)	TDS $mg\ell^{-1}$	MEI	Potential yield kg ha yr^{-1}
Sasaginnigak	5.5	45	8.18	3.75
Charron	17.8	31	1.74	1.79

Table 25. Trophic state indices of Sasaginnigak and Charron lakes.

Lake	Secchi disc m	TSI	Total Phosphorus mg/m^3	TSI
Sasaginnigak	1.7	52.3	20	41.3
Charron	3.2	43.2	20	41.3

Physical and Chemical Parameters

The temperature profile for Sasaginnigak Lake (Fig. 4) was close to the 20°C physiological optimum described by Hokanson (1977) for temperate mesotherm fishes. This was also true for the epilimnion of Charron Lake (Fig. 4). Although the hypolimnetic water of Charron Lake was much less than the 20°C physiological optimum, there was sufficient habitat in the epilimnion for walleye and pike. The hypolimnion had near saturated levels of dissolved oxygen so there was no restriction to lake trout. It would appear then, that the reduced growing season of the area (June to September) would have a greater effect on the growth of fish populations than summer extremes of water temperature.

The water chemistry data for Sasaginnigak and Charron lakes showed little spatial variation (Table 3). The values for specific conductance, total dissolved solids, nitrogen and phosphorous were similar to other Precambrian lakes on the east side of Lake Winnipeg (Hagenson and O'Connor 1980, 1981 and Hagenson 1983). The ionic composition was similar to that described by Armstrong and Schindler (1971) for dilute Canadian Shield lakes.

Fish

The age frequencies of the walleye and northern pike from Sasaginnigak and Charron lakes (Fig. 7 and 13) exhibited a good distribution of older age classes. This would indicate that although anglers were cropping some of the larger, older individuals, the

populations are not being adversely affected at this time. The same appears to be true for the lake trout from Charron Lake (Fig. 19). The creel census results for Sasaginnigak Lake indicated 44% of the walleye taken were age 7,8 and 9 and 65% of the pike taken were age 5,6 and 7 (Jardine and Sigurdson 1981).

The Walford estimates for asymptotic length indicated Charron walleye (523mm) to be larger than Sasaginnigak walleye (472mm). This was supported by an analysis of covariance of the exponential growth curves for Sasaginnigak and Charron lakes. It showed the Charron walleye curve to have a significantly greater elevation ($F = 12,21$, 1 and 31 d.f., $P \geq 0.05$) than the Sasaginnigak walleye curve. The L_∞ estimate for Sasaginnigak walleye using the creel census data (Jardine and Sigurdson 1981) was 439mm. This is less than the 472mm L_∞ estimate obtained from the standard gang data from this inventory. Slopes and elevations of exponential growth curves derived from creel census data and from this study were not significantly different ($F = 0.55$, 1 and 36 d.f., $P \geq 0.05$; $F = 0.03$, 1 and 37 d.f., $P \geq 0.05$). The difference in estimated L_∞ is due to the fact that walleye sampled during the creel census were somewhat smaller than the walleye captured in the standard gangs, over the age classes used to obtain the L_∞ estimate. A comparison of growth curves for walleye from Sasaginnigak and Charron lakes is presented in Fig. 22.

A comparison of exponential growth curves for Sasaginnigak and Charron walleye to those of walleye from other lakes on the east side of Lake Winnipeg is presented in Table 26. It indicates the

growth of Sasaginnigak walleye is the same as that of walleye from Vickers, Eardley and Dogskin lakes. Charron Lake walleye growth is the same as Family, Viking, Weaver and Morfee walleye growth. It would appear from this comparison of exponential growth curves that the Precambrian habitat on the east side of Lake Winnipeg produces similar growth rates for walleyes inhabiting those lakes. However, the asymptotic size can vary a great deal from lake to lake.

The condition factors of walleye from Sasaginnigak and Charron lakes were similar to those of walleye from other lakes on the east side of Lake Winnipeg (Hagenson and O'Connor 1980, 1981; Hagenson 1983).

The maturity regimes for the walleye sampled from Sasaginnigak and Charron lakes were similar to other east side Lake Winnipeg lakes (Hagenson and O'Connor 1980, 1981; Hagenson 1983). Walleye growth rates declined after mean ages of maturity were attained in both lakes. This conforms to the findings of Power (1978) who stated the growth of Arctic fish populations is relatively rapid until first maturity, when it becomes slow through a life span that may exceed 50 years.

It would appear from the preceeding comparisons of growth and maturity that there has not been a conspicuous response to exploitation as described by Spangler et al. (1977).

Adams and Olver (1977) showed the ratio of percid yield to total yield was independent of lake area and productivity which suggested a relatively stable equilibrium in an exploited percid

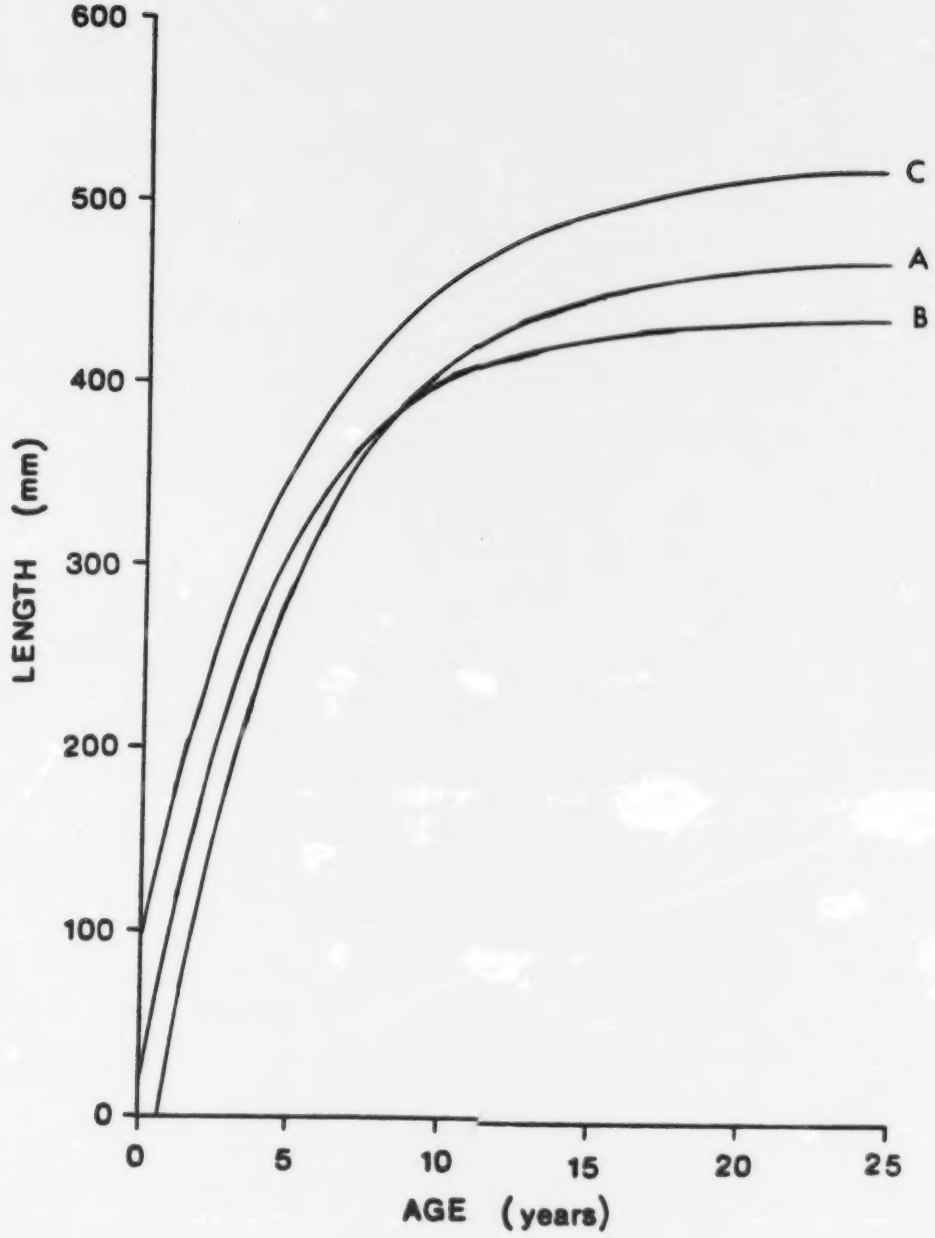


Fig. 22 Comparison of growth of walleye from Sasaginnigak inventory (A) Sasaginnigak creel census (B) and Charron Lake (C).

Table 26. Exponential growth curves for walleye from lakes on the east side of Lake Winnipeg.

Lake	Slope exponential curve	Group	Comparison	F ratio and d.f.
Vickers	0.480	1	Vickers-Sasaginnigak	3.49 (1,28)
Eardley	0.391			
Dogskin	0.383			
Sasaginnigak	0.379			
Ewart	0.335	2	Ewart-Carr-Harris	0.76 (1,30)
Aikens	0.329			
Harrop	0.324			
Carr-Harris	0.305			
Family	0.299	3	Family-Morfee	3.19 (1,25)
Viking	0.258			
Charron	0.226			
Weaver	0.218			
Morfee	0.208			
Obukowin	0.201	4	Obukowin-Wrong	4.42 (1,31)
Lynx	0.193			
Wrong	0.178			

community. Analysis of commercial catches from northwestern Ontario lakes showed that approximately one-third of the total yield (by weight) was percids. The average percid yield (by weight) from Sasaginnigak and Charron lakes was 27.7 percent, which is fairly close to the percid yield in northwestern Ontario lakes. The dominant percid was walleye in each of the lakes.

Condition factors of northern pike from Sasaginnigak and Charron lakes (Table 13) were similar to values obtained for northern pike from other lakes on the east side of Lake Winnipeg (Hagenson and O'Connor 1980, 1981; Hagenson 1983).

A comparison of exponential growth curves for northern pike from Sasaginnigak and Charron lakes to other lakes on the east side of Lake Winnipeg is presented in Table 27. It indicates pike in Weaver and Horseshoe lakes have the fastest rate of growth. There was no significant difference between the growth rate of northern pike from other east side Lake Winnipeg lakes. However, the asymptotic size these fish attained ranged from 662mm in Charron Lake to 2000mm in Wrong Lake. Toner and Lawler (1969) and Franklin and Smith (1963) have documented there is a great deal of variation in growth between different populations of northern pike.

The mean age of onset of sexual maturity for northern pike from Sasaginnigak and Charron lakes was 3.8 and 3.2 years respectively. This is similar to other lakes on the east side of Lake Winnipeg (Hagenson and O'Connor 1980, 1981; Hagenson 1983). It has been reported by Toner and Lawler (1969) that the total mortality of

Table 27. Exponential growth curves for northern pike from lakes on the east side of Lake Winnipeg.

Lake	Slope exponential curve	Group	Comparison	F ratio and d.f.
Weaver	0.616	1	Weaver-Horseshoe	12.60 (1,20)
Horseshoe	0.583	2	Horseshoe-Sasaginnigak	6.03 (1,16)
Sasaginnigak	0.505			
Viking	0.481			
Obukowin	0.469			
Wrong	0.443	3	Sasaginnigak-Charron	0.78 (1,15)
Dogskin	0.438			
Harrop	0.399			
Eardley	0.397			
Family	0.380			
Charron	0.364			

northern pike populations is 50 to 85%. Even when fishing pressure is low the total mortality appears to be about 50%. Franklin and Smith (1963) have found there is no direct relationship between adult abundance and strength of resulting year classes.

The small number of lake trout captured in Charron Lake may not give an accurate representation of the growth or maturity regimes of the population. The results should be interpreted with caution. The age-length relationship of lake trout from Charron Lake was similar to that reported by Johnson (1972) for Keller Lake. There is a great deal of overlapping of ages within given length groups, with most spawners being 400-600mm. However, it has been stated by Power (1978) that spawning is not an annual event for all mature individuals in a population of lake trout. A comparison of the age-specific mean lengths and weights of Charron lake trout (Table 19) to Second Cranberry lake trout (Gaboury 1984) indicates quite a difference in growth. An analysis of convariance of the exponential growth curves supports this ($F = 26.15$, 1 and 23 d.f., $P \geq 0.05$). However, the size the fish attain is not significantly different ($F = 0.26$, 1 and 24 d.f., $P \geq 0.05$).

The maturity regimes for both Charron and Second Cranberry lake trout were similar. The age at 100% maturity was age 9 in Charron Lake and age 10 in Second Cranberry Lake. These comparisons of age-specific data should be valid as the same methods and techniques for sampling and ageing were used for both samples.

The comparison of growth rates between Charron and Second

Cranberry conforms to the model proposed by Johnson (1976) where he postulated a feedback mechanism controls recruitment and growth in established populations of lake trout. As individuals are removed opportunities for smaller individuals to move forward and go through a period of rapid growth and reach equilibrium status are produced. The angler pressure on Second Cranberry is greater than the angler pressure on Charron (road access vs. fly in) and may be disturbing the equilibrium of the population producing faster growth rates.

However, Johnson (1976) and Power (1978) both caution that fishing pressure on a climax condition will reduce the level of organization of the system and produce oscillations in the size of the population. A collapse of the population can then be precipitated by direct fishing pressure or even small changes in the environment. Lake trout populations can only withstand limited exploitation. They can only maintain a large biomass at a very low turnover rate.

A comparison of mean biomass per mesh from Sasaginnigak and Charron lakes to other inventory lakes on the east side of Lake Winnipeg (Table 28) indicates that Sasaginnigak and Eardley are most comparable and Charron and Aikens are most similar. This is probably because both sets of lakes are very similar in morphometry and species composition. Each of these lakes contains the critical components and associated species detailed by Ryder and Kerr (1978) for a harmonic percid community in a boreal forest zone, a characteristic of which is high community integrity resulting in stability of biomass.

Table 28. Mean biomass per mesh (kg) from inventory lakes on the east side of Lake Winnipeg.

Lake	Mesh						
	3.81	5.08	7.62	9.52	10.79	12.70	Total
Sasaginnigak	3.5	4.3	7.7	5.2	4.5	1.6	26.9
Charron	0.8	1.2	4.4	3.8	1.8	3.4	14.1
Night Owl[1]	0.4	0.4	4.0	3.7	2.4	0.2	11.2
Horseshoe[1]	1.1	2.7	4.6	3.4	1.4	1.5	14.7
Long[1]	0.03	1.9	6.5	3.4	0.7	0.2	12.7
Morfee[2]	0.3	3.0	6.9	3.0	2.6	0.7	16.6
Ewart[2]	3.0	2.1	2.5	3.9	2.8	0.4	14.7
Lynx[2]	1.2	2.5	8.5	4.1	3.9	3.1	23.3
Carr-Harris[2]	1.7	1.8	3.2	1.9	3.8	0.4	12.8
Harrop[3]	1.8	6.3	12.2	8.7	4.5	1.9	35.4
Eardley[3]	2.2	4.5	9.7	5.7	4.6	1.6	28.3
Weaver[3]	3.7	7.3	16.8	11.4	10.5	3.4	53.1
Wrong[3]	1.8	6.3	15.9	9.7	9.8	5.3	48.9
Dogskin[4]	1.9	7.2	18.9	13.5	7.1	4.4	53.0
Family[4]	1.5	3.8	13.9	5.7	4.9	1.9	31.9
Viking[4]	2.8	4.8	9.1	7.7	5.0	1.8	31.3
Vickers[4]	0.9	1.2	6.8	4.4	2.6	0.7	16.6
Obukowin[5]	0.9	4.1	10.3	7.9	3.2	2.1	29.8
Aikens[5]	1.0	0.8	5.1	3.5	2.2	1.9	14.6

[1]Hagenson, 1983b

[2]Hagenson, 1983a

[3]Hagenson and O'Connor, 1981

[4]Hagenson and O'Connor, 1980

[5]Hagenson and O'Connor, 1979

Angling quality, total domestic, sport and commercial harvest and MSY calculations from Gods Lake were used to determine that no more than 15% of the MSY should be harvested to insure sustained high quality sport fishing (Hagenson and O'Connor 1978). The estimates for sustained high quality angling for Sasaginnigak and Charron are given in Table 29. The creel census results for Sasaginnigak Lake (Jardine and Sigurdson 1981) indicated the angler harvest to be in the range of 1.6 kg/ha/yr to 2.33 kg/ha/yr. The average kill rate was 4.5 kg/angler/day for this creel census. Multiplying this figure by the extrapolated angler days for the season (2510) yields the 2.3 kg/ha/yr harvest estimate.

Table 29. Estimated angling yield for Sasaginnigak and Charron lakes based on high quality fisheries.

Lake	MEI	MSY	Estimated high quality angling yield kg/ha/yr
Sasaginnigak	8.18	3.75	0.56
Charron	1.74	1.79	0.27

Angler success at Sasaginnigak Lake was 0.63 walleye and 0.30 northern pike per angler hour (Jardine and Sigurdson 1981). According to the anglers interviewed they rated this success rate low to medium quality. However, a rating of angler success developed by Andrews (1968) would place the walleye fishing as excellent and the northern pike success as good (Table 30). The more recent evaluation of angler success reported by Jardine and Sigurdson (1981) for Sasaginnigak probably provides a better reflection of angler expectations in a fly-in lake.

Table 30. Categories of fishing success based on catch in numbers of fish per angler hour.

Species	Catch Categories			
	Poor	Fair	Good	Excellent
Pike	0.00 - 0.06	0.07 - 0.21	0.22 - 0.64	0.65 -
Perch	0.00 - 0.01	0.02 - 0.04	0.05 - 0.13	0.14 -
Walleye	0.00 - 0.09	0.10 - 0.24	0.25 - 0.55	0.56 -
Lake Trout	0.00 - 0.01	0.02 - 0.04	0.05 - 0.07	0.08 -

An examination of the Manitoba Master Angler Awards from 1972 to 1983 (Appendix 5) shows wide fluctuations in the number of awards from Sasaginnigak and Charron lakes. The overall trend for northern pike awards has been a decline. In the period 1972 to 1978 the mean number of master angler northern pike from Sasaginnigak was 12.8 per year. During this same period the number of pike awards

for Charron Lake peaked at 6 in 1976. The mean number of pike awards for Sasaginnigak Lake in the period 1979 to 1983 was just 3.8 per year and Charron produced only 1 or 2 per year. There have been no master angler walleye reported from Charron Lake. The number of master angler walleye from Sasaginnigak fluctuated a great deal from year to year with a mean of 7.5 per year. The minimum qualifying weight is 3.6 kg for walleye and 9.0 kg for northern pike.

It would appear the angling pressure on Charron and Sasaginnigak lakes has been sufficient to crop some of the older, larger northern pike from these lakes. The documented high egg production capacity of northern pike populations will likely keep the northern pike population stable, but the quality of the fishery will not improve under this level of exploitation.

Although the angling pressure on the walleye populations of Sasaginnigak is cropping some older, larger individuals the decline exhibited by the pike population was not evident in walleye. The variables for angler pressure, year class strength and natural mortality appear to be combining to produce a fairly stable older population of walleye which offers some trophy potential for guests at Sasaginnigak Lake.

MANAGEMENT IMPLICATIONS

Sasaginnigak and Charron lakes are relatively large headwater lakes on the Precambrian Shield. The trophic status of the lakes ranges from oligotrophic to mesotrophic depending on the classification system used, MEI or TSI. In either case, the productive potential of these lakes is low.

The latest creel census data for the east side of Lake Winnipeg shows the average angler harvest per day to be 5.44 kg (Jardine and Sigurdson 1981, D. Fitzjohn Pers. Comm.). It has been reported by SPOF Working Group No. 12 (1982) that the potential yield of a lake, determined by Ryders morphoedaphic index, may be partitioned into individual species yields (32% for walleye and 25% for northern pike sport fisheries). Therefore, for a self-sustaining moderate quality sport fishery no more than 57% of the MSY should be taken. The average occupancy rate for lodges on the east side of Lake Winnipeg over a 120 day season is approximately 45% (C. Wall Pers. Comm.). Combining this information into the following formula (J. O'Connor Pers. Comm.) provides an estimate of the number of beds these lakes can support:

$$\text{No. of beds} = \frac{\text{MSY X .57 X Area}}{\text{HxSxO}}$$

where H = harvest (5.44 kg. day^{-1})
S = season (120 days)
O = occupancy (45%)

From the equation Sasaginnigak should have 35 beds and

Charron 18 beds.

The results of this inventory indicate the present level of angler harvest on Sasaginnigak Lake has cropped the northern pike population and is keeping it at a depressed level, thus reducing the trophy potential for northern pike. The walleye population appears not to be adversely affected at this time. However, it may be in the best interests of the owners of Sasaginnigak Lake lodge to reduce the number of beds to 35 or instill a camp policy of reduced kill. By doing this and strictly monitoring guests creel limits to insure there is no overfishing, the trophy potential of Sasaginnigak may be increased.

It appears the size of the outcamps on Charron Lake can be increased by a total of 4 beds. However, the potential angler harvest from the extra 4 beds maybe sufficient to deplete the lake trout population of Charron Lake to the point where, a collapse of the population may result. Therefore, to conserve the lake trout of Charron Lake, no increase in beds should be considered.

RECOMMENDATIONS

1 The number of beds at Sasaginnigak Lake lodge not be increased and if it is economically viable to the management of the lodge the number of beds could be reduced to attempt to improve the trophy potential of the lake.

2 Lodge and outcamp owners encourage a reduced creel limit and enforce length limit restrictions of their guests.

3 The number of outcamp beds on Charron Lake should not be increased.

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Appendix 1. Plankton and benthos collected from Sasaginnigak Lake.

Determined by P.M. Laufersweiler

CYANOPHYTA (Blue-Green Algae)

Anabaena
Aphanizomenon
Chroococcus?
Gloeotrichia
Gomphosphaeria naegliana
Microcystis aeruginosa
M. (formerly *Aphanocapsa* spp)
M. wesenbergii

CHLOROPHYTA (Green Algae)

Ankistrodesmus (Selenastrum)
Chlorella?(and *Zoo-Chlorella* on *Copepods*)
Dictyosphaerium pulchellum
Dimorphococcus
Paulschulzia
Pediastrum duplex
P. duplex v. *gracilimum* or *reticulatum*
Sphaerocystis?

Desmidiaceae

Closterium (kuetzingii?)
C. sp 1
Spondylosium
Staurastrum
Staurodesmus subtriangularis v. *inflatus*
Teilingia

Chrysophyta (Yellow-Brown Algae)

Chrysosphaerella multispina
Dinobryon bavaricum
D. divergens
Mallomonas
Synura uvella

Bacillariophyceae - Preliminary Analysis

Asterionella
Cyclotella
Diatoma
Fragilaria
Melosira

Neidium?
Pinnularia
Rhizosolenia
Stauroneis?
Stephanodiscus
Surirella
Synedra
Tabellaria

PYRRHOPHYTA (Dinoflagellates)

Ceratium hirundinella

PROTOZOA

Cilatae — *Difflugia?*

ROTIFERA

Asplanchna
Kellicottia
Keratella
Polvarthra

ANNELIDA

Oligochaeta

ARTHROPODA

Crustacea

Branchiopoda

Cladocera

Bosmina
Daphnia
Diaphanosoma
Holopedium

Copepoda

Calanoida

Diaptomus

Cyclopoida

Cyclops
Mesocyclops edax
Tropocyclops?

Insecta

Diptera

F. Chaoboridae
Chaoborus
F. Chironomodae
Chironomus
Cladopelma
Micropsectra or *Tanytarsus*

Ephemeroptera

F. Ephemeridae
Hexagenia

Appendix 2. Plankton and benthos collected from Charron Lake.

Determined by P.M. Laufersweiler

CYANOPHYTA (Blue-Green Algae)

Anabaena
Aphanizomenon
Aphanothece
Chroococcus
Gomphospaheria lacustris
G. naegliana
Lyngbya
Microcystis aeruginosa
M. (Aphanocapsa spp.*)*
Pseudanabaena mucicola
Synechococcus?

CHLOROPHYTA (Green Algae)

Crucigenia rectangularis
C. tetrapedia
Dictyosphaerium nr. *elegans*
D. pulchellum
Dimorphococcus
Elakatothrix
Eudornia
Gloeocystis
Kirchneriella
Mougeotia?
Oocystis
Paulschulzia
Pediastrum duplex *f. rugulosum*
Quadrigula
Scenedesmus
Sphaerocystis
Ulothrix

Desmidiacea

Closterium (aciculare?)
Cosmarium
Hyalothece dissiliens
Spondylosium
Staurastrum
Staurodesmus controversus v. *alaskensis*
cf *convergens*
S. cuspidatus v. *curvatus*

S. glaber v. *limnophilus*
S. mamillatus v. *maximus*
S. megacanthus?
S. mucronatus subtriangularis

CHRYSOPHYTA (Yellow-Brown Algae)

Chrysosphaerella multispina
Dinobryon bavaricum
D. cylindricum v. *palustre*
D. divergens
D. sertularia
D. sociale
D. tabellariae?
Mallomonas
Synura uvella

Bacillariophyceae - Preliminary Analysis

Asterionella
Coscinodiscus
Cyclotella
Diatoma?
Fragilaria
Melosira
Rhizosolenia
Stephanodiscus
Surirella
Synedra
Tabellaria

PYRRHOPHYTA (Dinoflagellates)

Ceratium hirundinella
Gymnodinium

PROTOZOA

Ciliatae

Difflugia?
Epistylus
Vorticella

ROTIFERA

Asplanchna
Gastropus
Kellicottia
Keratella
Polyarthra
Trichocerca

ANNELIDA

Oligochaeta

ARTHROPODA

Crustacea

Amphipoda

Pontoporeia

Branchiopoda

Cladocera

Chydoras
Daphnia
Diaphanosoma
Holopedium

Conchostraca

Copepoda

Calanoida

Diaptomus
Limnocalanus macrurus

Cyclopoida

Insecta

Diptera

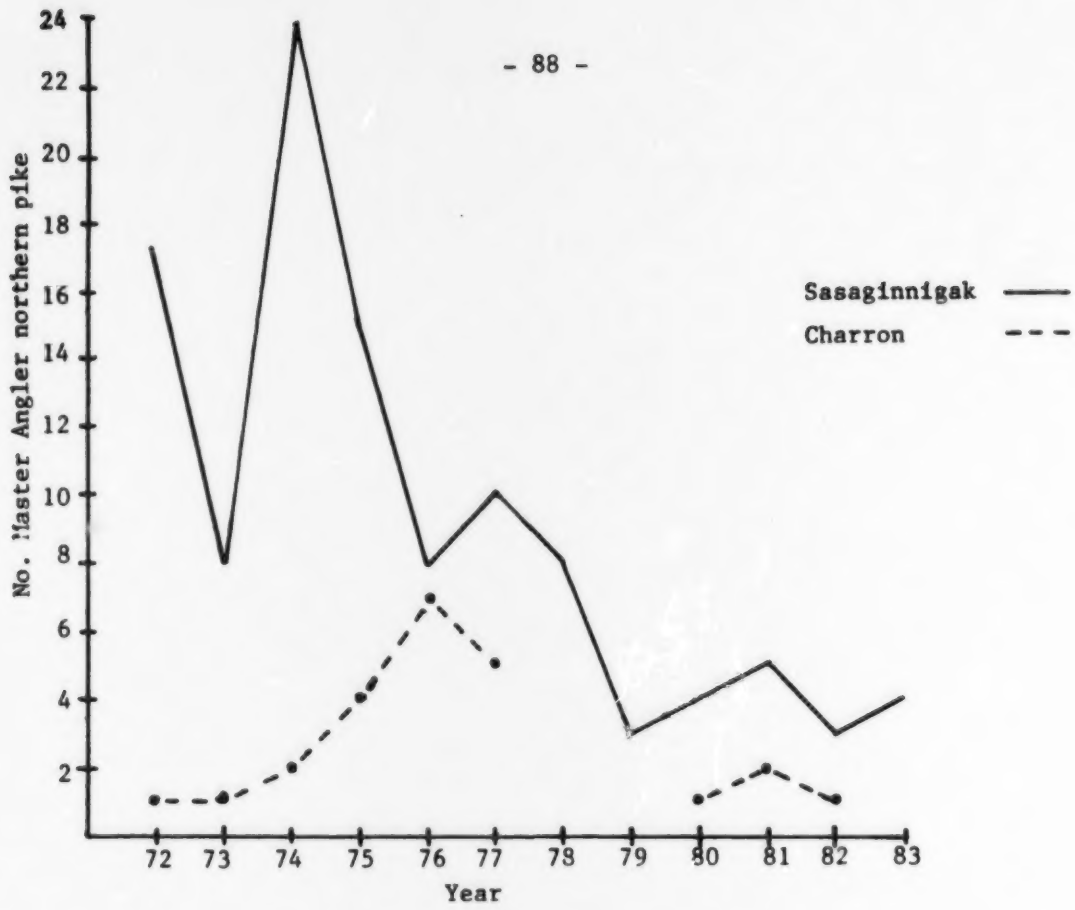
F. Chironomidae
Chironomus
Harnischia

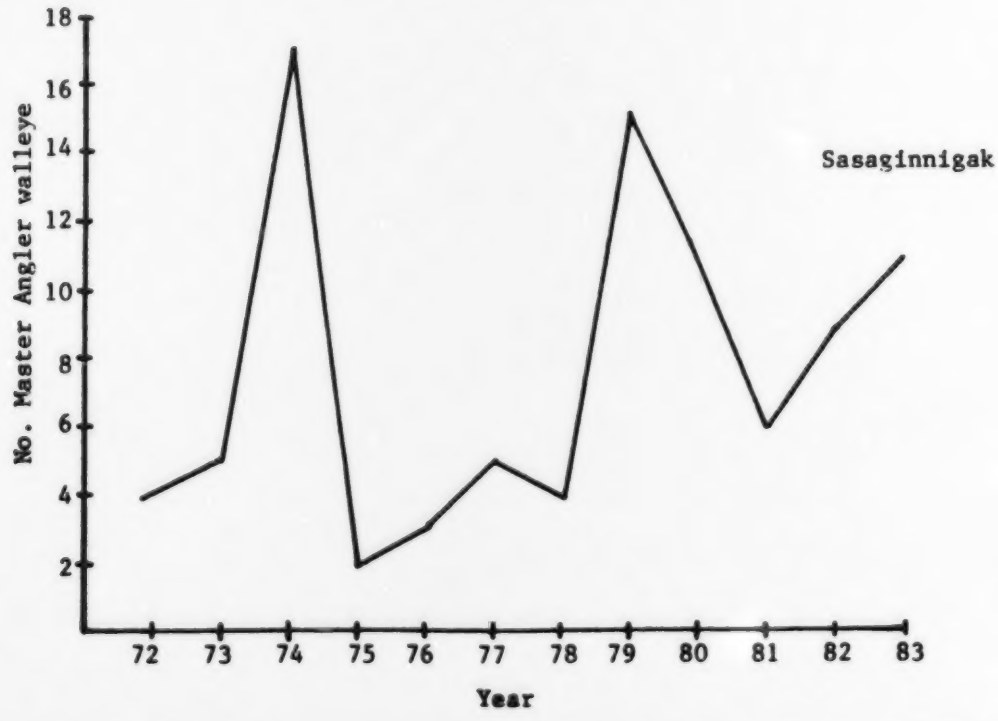
Appendix 3. Catch summary of net sets 1 to 10 made in Sasaginnigak Lake.

Set Location	Date of Set	Walleye	Northern pike	Yellow perch	Whitefish	White sucker	Shorthead redhorse	Cisco	Total
1	June 23	37	7	1	1	4	3	23	76
2	June 23	8	6	–	–	–	–	4	18
3	June 23	30	12	2	1	5	4	16	70
4	June 24	34	9	2	1	10	1	47	104
5	June 24	9	9	–	–	–	–	6	24
6	June 24	4	9	–	2	1	–	93	109
7	June 25	4	–	–	–	–	–	1	5
8	June 25	19	5	1	–	–	–	21	46
9	June 25	17	7	3	–	5	1	13	46
10	June 26	17	2	–	–	–	–	4	23
Total caught		179	66	9	5	25	9	228	521
Total sampled		179	66	9	5	25	9	228	521
Total aged		170	66	–	–	–	–	–	236

Appendix 4. Catch summary of net sets 1 to 20 made in Charron Lake.

Set Location	Date of Set	Walleye	Northern pike	Lake trout	Whitefish	Cisco	Yellow perch	White sucker	Burbot	Total
1	July 18	-	2	-	3	1	-	-	1	7
2	July 18	2	-	3	9	-	-	-	2	16
3	July 18	1	-	-	1	1	-	-	1	4
4	July 19	-	-	3	-	-	-	-	-	3
5	July 19	3	1	6	2	5	-	-	-	17
6	July 19	3	8	-	-	-	-	5	-	16
7	July 20	-	-	1	5	5	-	4	1	16
8	July 20	-	-	-	2	1	-	1	1	5
9	July 20	2	-	1	11	1	-	2	2	19
10	July 21	13	1	2	9	2	-	-	-	27
11	July 21	4	2	6	7	2	-	-	2	23
12	July 21	2	7	-	1	-	1	4	-	15
13	July 22	-	5	-	2	-	-	2	-	9
14	July 22	11	-	2	12	10	-	1	2	38
15	July 22	24	-	2	1	-	-	2	-	29
16	July 23	1	4	-	-	-	-	2	-	7
17	July 23	1	-	-	-	-	-	2	-	3
18	July 24	2	3	-	-	-	2	4	-	11
19	July 24	18	-	1	3	-	-	-	1	23
20	July 24	1	-	4	10	6	-	-	18	39
Total caught		88	33	31	78	34	3	29	31	327
Total sampled		88	33	31	78	34	3	29	31	327
Total aged		87	32	31	-	-	-	-	-	150





Appendix 5. Master Angler awards for walleye and northern pike from Sasaginnigak and Charron lakes.